1995 Report to the Congress on

Ballistic Missile Defense

September 1995

Prepared by the Ballistic Missile Defense Organization

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Dist A. per Acq. thr
U96-01-0045

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Strategy And Objectives

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Strategy And Objectives

1.1 Introduction

This report responds to the annual reporting requirements specified by section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), as amended by section 240 of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160), as summarized in Appendix B. It describes the overall Ballistic Missile Defense (BMD) strategy, describes the discrete programs and projects included in the overall effort, addresses international participation in BMD research, certifies compliance of planned development and testing program with existing arms control agreements, and provides details of current and planned funding for BMD. Chapters 2, 3, and 4, which describe the program strategy, architecture, and planning for Theater Missile Defense (TMD), National Missile Defense (NMD), and Advanced Technology programs, respectively, specifically respond to the reporting requirements of Section 224(b)(1) and (b)(2); Chapter 5 describes the funding requirements of the BMD program in response to Section 224 (b)(8); Chapter 6 addresses Antiballistic Missile (ABM) Treaty compliance per Section 224 (b)(6); Chapter 7 addresses the status of international consultations as required by Section 224 (b)(5); and Chapter 8 addresses efforts regarding countermeasures required by Section 224 (b)(7), as they relate to the current BMD program. The reporting requirements uniquely related to the earlier Strategic Defense Initiative (SDI) program, directed at a phased deployment of defenses to counter a massive Soviet attack, have been carefully considered in developing the report, but are not specifically addressed since they are no longer germane to the planned BMD program. These provisions include Section 224(b)(3), (4), (7), (9), and (10).

1.2 Ballistic Missile Defense (BMD) Program Priorities

The Department of Defense (DoD) has made Theater Missile Defense the top priority of the Ballistic Missile Defense Organization (BMDO), with National Missile Defense Technology Readiness Program as a second priority, and an Advanced Technology program as a third priority.

The Department's objective is to develop, procure, and deploy TMD at a level that will enhance U.S. warfighting capabilities and complement the effectiveness of its combat forces. This plan envisions the time phased acquisition of a multitier defensive capability. The first phase consists of near term improvements to existing systems using low risk, and quick reaction programs, while simultaneously refining concepts of operations and tactics. The second phase develops a significant core capability. This core capability consists of land based defenses to protect critical assets and to provide theater-wide protection, and Navy capability to protect U.S. and friendly forces in littoral (coastal) areas. The core capability also provides improved lethality and probability of kill through the use of interceptors which employ advanced concepts such as hit-to-kill or improved guidance techniques combined with fragmentation warheads as well as engagement opportunities at both lower altitudes and shorter ranges (lower tier intercepts within the atmosphere), and at higher altitudes and longer ranges (upper tier, exoatmospheric and high endoatmospheric intercepts). In the final phase, advanced concepts for TMD will be developed.

As a second priority of missile defense, the NMD program is structured as a "technology readiness" program that is focused on resolving key element and system level technical issues related to the development and maintenance of options to deploy ballistic missile defenses for the U.S. This program was developed as a result of the Department's Bottom-Up Review (BUR) in 1993. The focus of the program is to develop and test the capability of critical NMD technologies while conducting planning that would reduce the time required to deploy a contingency NMD system. This focus is intended to provide increasingly capable options for deployment in as short a time as possible after a decision to deploy.

Prior to the BUR decision, the NMD program was structured as an acquisition program aimed at defending against Global Protection Against Limited Strike (GPALS) sized threats (up to as many as 200 reentry vehicles). Deployment of a first site was at least ten years away, and contingency deployment was not planned. Multiple sites were envisioned for the objective system, and relief from ABM Treaty constraints would have been required. The change in priority and direction for the NMD program coming-from the BUR reflects the changes in the threat environment from the earlier GPALS threat. The new NMD strategy accommodates the uncertainty of the threat to the United States and the reduced level of funding. It also allows an evolution of capability as technology matures.

The third priority is an Advanced Technology program to provide technology options for improvements to planned and deployed defenses. The program will invest in high leverage technologies that yield improved capabilities for TMD and NMD interceptors and sensors. The improvements will focus on responding to several potential developments:

- The deployment of countermeasures on theater ballistic missiles;
- The use of advanced submunitions in ballistic missile warheads;
- Lessons learned from operational experience with TMD systems.

1.3 Cooperation with Allies and Friends

As part of broader efforts to enhance the security of U.S. and allied forces against ballistic missile strikes and to complement counterproliferation strategy, the United States is exploring opportunities for cooperation with its allies and friends in the area of TMD.

The U.S. approach to allied participation in research, development, and acquisition of ballistic missile defense has evolved as the ballistic missile program has changed. Cooperation started as a concerted effort on the part of the United States to consult friends and allies regarding the direction of U.S. initiatives. Consultation evolved into active participation in technology development and, most recently, cooperation has started to focus on development of interoperable theater missile defense systems. The latest stage of cooperation results from DoD giving high priority to armaments cooperation, thereby providing impetus to the process of involving allies and friends in BMD programs.

The international community increasingly recognizes the existence and growth of the threat of ballistic missile attack and, as a consequence, commitments to Theater Missile Defense (TMD) development efforts by friends and allies have been rising. The United States has established several working groups to explore the possibility of cooperation in the area of TMD. To capitalize on the interest in TMD cooperation shown by many allies, the United States is taking an evolutionary and tailored approach to allied cooperation in order to accommodate varying national programs and plans, as well as the special capabilities of particular nations. The approach may include a menu of items such as bilateral or multilateral research and development, improvements to current missile capabilities, off-the-shelf purchases, and more robust participation such as codevelopment and coproduction programs.

In the U.S. view, cooperation in TMD, whatever form it takes, will help strengthen security relationships with allies, help offset costs, will enhance the U.S. counterproliferation strategy of discouraging acquisition and use of ballistic missiles and, should that fail, will protect against the threats posed by such systems.

1.4 Antiballistic Missile Treaty

During the past year, the Administration has pursued two agreements to update and clarify the Antiballistic Missile (ABM) Treaty while preserving its viability. The first would provide the States of the former Soviet Union the opportunity to succeed to the ABM Treaty, making explicit the Treaty parties and their responsibilities. The second would clarify the distinction between ABM systems, which are limited by the Treaty, and non-ABM systems, which are not. The United States and Russia both believe this clarification is necessary to facilitate the deployment of effective theater missiles while maintaining the Treaty. An agreement on the distinction between ABM and non-ABM systems would assist U.S. efforts to develop and deploy effective TMD systems for the protection of U.S. forces, allies and friends. These two agreements are being pursued multilaterally in the Standing Consultative Commission; in addition, there have been bilateral U.S./Russia discussions on ABM/non-ABM demarcation at the political level.

1.5 Conclusion

The U.S. ballistic missile defense program is a balanced program directed toward developing TMD, which is a critical component of a national security strategy that focuses on regional crises and proliferation; pursuing the technologies needed for evolving an NMD capability and maintaining a readiness to deploy such a capability when needed; and exploring advanced technologies essential for defenses against future threats. The remaining chapters in this report discuss program objectives in greater detail, describe the programs and projects being pursued to achieve these objectives, and summarize the current status and plans for each program.

Chapter 2

Theater Missile Defense Master Plan

Chapter 2
Theater Missile Defense Master Plan

2.1 Mission and Scope

The mission of Theater Missile Defense (TMD) is defined in Joint Pub 3-01.5, "Doctrine for Joint Missile Defense," and the Theater Missile Defense Mission Need Statement: "The mission of TMD is to protect U.S. forces, U.S. allies, and other important countries, including areas of vital interest to the U.S., from theater missile attacks." The TMD mission includes protection of population centers, fixed civilian and military assets, and mobile military units.

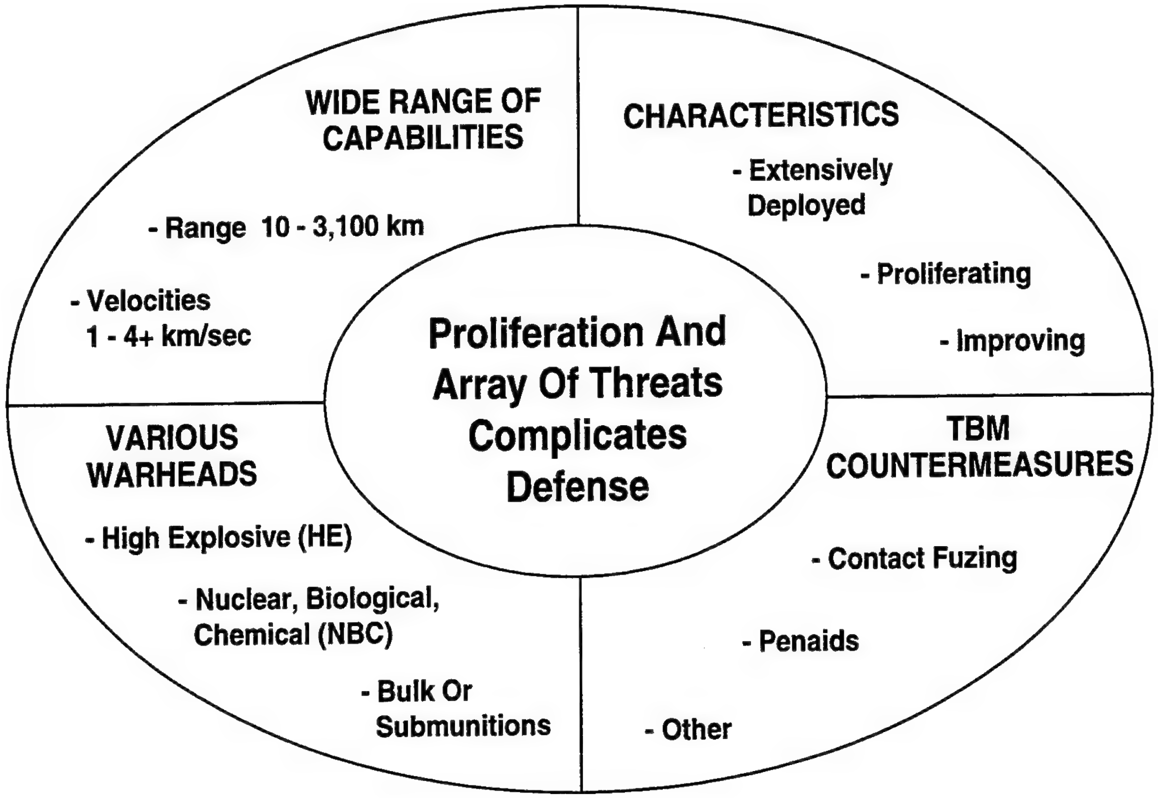
The mission need statement also provides a basis for defining the scope of the program in terms of areas of TMD and the threats to be countered. It identifies four areas of TMD frequently called "pillars": attack operations, active defense, passive defense, and Command, Control, Communications, and Intelligence (C^3I). The scope of the Ballistic Missile Defense Organization (BMDO) TMD program is to focus on active defense and the associated C^3I. The mission need statement defines a theater missile as "ballistic missiles, cruise missiles, and air-to-surface guided missiles whose target is within a theater or which is capable of attacking targets in a theater." Previously, BMDO has concentrated on the ballistic missile threat while the Services continued to develop counters to the other theater missiles.

Two studies have been initiated to evaluate the integration and overall effectiveness of planned systems to counter the current and future ballistic missile and cruise missile threats. These studies are: the Theater Defense Netting Study (TDNS), which was completed in November 1994, and the Comprehensive TMD Missions and Programs Analysis, which will be completed by October 1995. The Comprehensive TMD Missions and Programs Analysis includes four related studies: the TMD Cost and Operational Effectiveness Analysis (COEA), the Technical and Engineering Commonality Analysis, the TMD Command and Control Plan, and the Threat and Mission Priorities Analysis. These analyses are discussed later in this plan.

2.2 Threat

The Theater Ballistic Missile (TBM) threat has continued to evolve as anticipated and our projections of this threat, which is reflected in DIA reference, Proliferation of Weapons of Mass Destruction(U), PC-16000-31-95, February 1995, remain unchanged. Ballistic missiles have been used in six regional conflicts since 1973 - the most recent of which was the 1994 conflict between North and South Yemen involving Scud missiles armed with conventional weapons. The 1988 Iran-Iraq War of the Cities, Operation Desert Storm, and the recent conflict in Yemen have demonstrated that ballistic missiles will pose a threat to U.S. and allied forces and civilian population centers. At the beginning of 1994, there were approximately 8,800 short-range (50 - 500 kilometers) theater ballistic missiles in service in 32 countries. Thirty new types of TBMs are in development. Figure 2-1 summarizes the current TBM threat.

Figure 2-1. Summary Of The Theater Ballistic Missile Threat



In summary, TBMs are extensively deployed and, because of their low cost and availability, they are proliferating throughout the world. A wide range of capabilities are available depending upon the cost a particular nation is willing to pay and technologies used. Adding to the complexity of the threat is the potential availability of various warheads including high explosives, bulk or submunitions, and weapons of mass destruction — nuclear, biological, and chemical. The evolving threat may also employ countermeasures to reduce the effectiveness of Theater Missile Defense (TMD) systems. Thus, the array of TBM threats and their proliferation significantly complicates the theater missile defense mission.

2.3 Doctrine, Tactics, and Training

2.3.1 Joint Doctrine

The future success of theater missile defenses will rest on doctrine as well as on new weapon systems and force structure. To view Theater Missile Defense (TMD) as a purely weapons driven program is to miss the magnitude of the problems facing the warfighter. Issues such as decentralized versus centralized control of TMD assets, the integration of TMD systems within an existing air defense force structure, and the amount of prepositioned TMD force structure in the theater will be dominant themes in the coming years.

The Department of Defense Joint Publication 3-01.5, Doctrine for Joint Theater Missile Defense defines the activities and performance of the Armed Forces in joint and multinational operations. It provides guidance for combatant commanders and other joint force commanders, and prescribes doctrine for joint operations and training. Based on this doctrine, the Joint Staff (J-36) is promulgating a joint TMD Concept of Operations (CONOPS) to provide guidance to the Commander In Chiefs (CINCs) and encourage commonality of equipment and operational procedures. The guidance provided in the new doctrine includes:

- Cruise missiles are included in the scope of theater missile defense;
- TMD is recognized as a joint-Service and multinational mission requiring the integration of all Service and host nation systems;
- TMD systems must be easily transportable and mobile for rapid emplacement and relocation in order to be effective across the entire range of military operations;
- No single system or technology can counter the entire spectrum of the theater missile threat;
- TMD systems must integrate with the existing command and control architecture. This provision has far-reaching implications for both TMD concepts and the existing air defense structure that will incorporate dual purpose systems.

The Commanders-in-Chief (CINC) Assessment Program is exploring the issues of command, control, and force interoperability addressed in the new TMD doctrine. This program is discussed in more detail in paragraph 2.8.5.

Logistics and asset prepositioning will continue to be a major concern to theater commanders. With changes in doctrine and the international security environment, the U.S. has moved from a force structure that was largely forward based to one that is largely based in the Continental United States (CONUS). These CONUS based assets must be deployed to regional theaters as needed to support the operational commanders. The need to mobilize and transport large inventories of personnel and equipment will stress air, land and sea lift capabilities in coming years. Prioritizing assets for transport in the crucial first days of an overseas campaign will present a critical challenge. During the Gulf War, our TMD forces were already in place, trained and integrated into the joint force structure when the first enemy missiles were launched. Future campaigns will not likely be conducted under such favorable circumstances. In fact, an enemy may choose to expend the majority of his theater missiles well before our TMD assets can arrive on the scene. The major problem, then, is how much force structure we can preposition and where TMD forces should be programmed into an already overburdened air and sealift system.

The following paragraphs present the Army, Navy, and Air Force doctrine, tactics, training, and force structure for theater missile defense operations.

2.3.2 Army Doctrine

The role of Army TMD is to support the national military strategy of defense from theater missile attacks by protecting the force, conducting precision strikes, and dominating the maneuver battle-

field. In fulfilling this role, virtually all operational scenarios envision the deployment of Army TMD forces as part of joint forces. Army TMD provides theater CINCs with the ability to protect forces, whether they are ground maneuver units, air bases, or naval port facilities, from the threat of theater missiles. The Army does this in two ways. First, by destroying enemy missiles in flight (active defense) and, second, by conducting precision strikes against opposing missile launch capabilities (attack operations).

Evolving Army TMD doctrine calls for a highly capable and robust ground based defense that is rapidly deployable and sustainable in contingency theaters to support force projection operations. Army TMD doctrine will coincide with TMD joint doctrine and operational principles described in Joint Publication 3-01.5, Doctrine for Joint Theater Missile Defense. Army Field Manual, FM 100-5, Operations, the authoritative foundation for subordinate Army doctrine, recognizes that the threat to friendly forces has grown due to weapons of mass destruction and the proliferation of missile technology. In defining the requirement for force protection in each phase of an operation, FM 100-5 calls for a greater role for theater missile defense as an enabler for the generation of combat power. An active TMD operational concept published by the U.S. Army Training and Doctrine Command (TRADOC) as a precursor to more weapon specific doctrine, describes how a PATRIOT and Theater High Altitude Area Defense (THAAD) task force will operate to provide a near leak proof, two tiered defense of critical assets within a theater. Specific "how to fight" tactics are emerging with evolving doctrine from lessons learned in the Gulf War and from ongoing war gaming and analysis efforts, including the current TRADOC TMD Advanced Warfighting Experiment. The Medium Extended Air Defense System (MEADS) program is intended to satisfy the operational requirements for a corps area air/missile defense capability that will provide protection to maneuver forces from attack by both ballistic missiles and cruise missiles. Doctrine and tactics for this program, which replaces Corps SAM, will mature with system definition.

Steps to increase leader and soldier proficiency in TMD will include incorporating the theater missile threat and TMD responses into all levels of training and service school programs of instruction, and capturing and understanding the lessons learned from recent combat experience. TMD will be integral to the live field training exercises at the combat training centers and to the Battle Command Training Program, a training tool for corps and division commanders that uses constructive simulation and situational scenarios to execute large unit operations.

2.3.3 Navy Doctrine

The new security environment emphasizes the need for naval forces that can operate in any littoral (coastal area) theater, in any mission, to provide a forward presence and initial capability when no other assets exist and, if necessary, to participate in joint expeditionary warfighting. Accordingly, the Navy's role in the post Cold War era has become prompt and sustained combat operations that are not so much "on the sea" as "from the sea."

The inherent mobility of naval forces and their capability for integrated warfighting make them an important foundation for CINC contingency planning and phased response to regional crises. Navy TMD systems will be capable of creating an immediate defensive umbrella against all threats to expeditionary forces as they assemble and move from the sea to the shore. If forced entry is required, the Navy's role will be to provide highly survivable active defense, complemented by attack operations against enemy missile sites and other key targets. Where immediate command and control of air and TMD is required, the Navy may be assigned duties as the Joint

Force Air Component Commander (JFACC) by the Joint Force Commander. As joint forces continue to build and begin to move inland, the Navy's role will expand to include managing and defending the logistics train, as well as extending the reach of attack operations. At that time, JFACC responsibilities may move from being a JFACC afloat to a JFACC ashore.

Command and control issues are being updated in operational doctrine and CONOPS at the training commands. The revised CONOPS will be incorporated in shore and sea based training. Within a theater-level architectural perspective, all functional areas, from intelligence and surveillance to post engagement assessment, are being scrutinized for optimum effectiveness in joint operations. Operational demonstrations and experiments are used to verify progress in system engineering and doctrine evolution. At present, selected fleet units are practicing key areas of TMD tactics and procedures and the results will be incorporated in formal training and readiness exercises in the future.

2.3.4 Air Force Doctrine

The Department of Defense (DoD) designated the Air Force the Executive Agent for Theater Air Defense Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^4I) in a memorandum signed by the Assistant Secretary of Defense for Command, Control, Communications And Intelligence (C^3I) dated July 8, 1994. As the Executive Agent, the Air Force is responsible for constructing a theater air defense BM/C^4I architecture that will provide the CINCs a flexible system to manage active defense against both aircraft and theater missiles. Requirements for TMD BM/C^4I are being coordinated with AF/TAA, which is the office designated by the Secretary of the Air Force as the USAF Executive Agent for Theater Air Defense.

The Air Force plays several vital roles in providing a TMD capability to the theater CINCs. Starting with missile detection and warning, the Air Force is meeting the Theater Ballistic Missile (TBM) challenge by integrating a mix of mutually supportive passive defense, active defense, attack operations, and battle management command, control, communications, and intelligence systems. The Air Force contributes to the campaign through tactical missile warning, cueing ground based forces, attack operations, offensive and defensive counter-air, and air interdiction capabilities. When the Air Force is assigned duties as the JFACC, it will plan and maintain visibility on the theater-wide attack operations effort.

Theater air defense criteria include detecting, identifying, tracking, intercepting, and destroying enemy aircraft, cruise missiles and theater ballistic missiles, and their associated support infrastructure. The compressed command and control time inherent in theater missile operations requires improved sensor target detection, tracking and identification capabilities, a joint battle management/command, control and communications architecture that includes decision aides, and streamlined execution of command and control functions. The connectivity between Services must allow for multiple engagements, integrated targeting, and flexible response options to negate the TBM threat. Procedures and training must be established prior to the start of a theater conflict to ensure the greatest efficiency of a multilayered TMD capability. The theater missile threat requires TMD weapon systems to be capable of near real-time discrimination, engagement decisions, and coordination with other Services' systems. For attack operations and boost phase interception, the TMD BM/C^3I must perform near real-time target identification, retargeting, and inter-Service engagement planning. Attacking mobile targets within minutes and seconds must be the norm and requires full integration of all assets.

2.3.5 Marine Corps Doctrine

While the Marine Corps does not yet have a formal TMD doctrine, program improvements and capability upgrades of the HAWK missile system and the AN/TPS-59 radar both on the joint and service levels are rapidly driving doctrine and architecture development. Marine Corps need for TMD capability was outlined in their 1992 TMD Mission Need Statement. Their current weapons systems will continue to be upgraded as doctrine evolves and is incorporated into current anti-air warfare programs. Current Marine Corps philosophy is to plan for the detection and engagement of theater missiles within their current doctrine for air defense; joint TMD operations will be conducted with units operating with the Marine Air Ground Task Force (MAGTF). The Marine Corps also provide for attack operations.

In addition to the HAWK missile system, the Marine Corps has expressed an interest in Corps SAM. In a joint memorandum of agreement signed by the Vice Chief of Staff of the Army and the Assistant Commandant of the Marine Corps, the requirement and need for Corps SAM by the Marine Corps was identified.

2.4 Force Structure

2.4.1 Army

Army planned active defense force structure consists of PATRIOT, Theater High Altitude Area Defense (THAAD), and Medium Extended Air Defense System (MEADS) (formerly Corps SAM) forces along with Joint Tactical Ground Stations (JTAGS). Currently, the programmed PATRIOT force includes 88 firing batteries (or fire units). Of these, 44 comprise the nine operational PATRIOT battalions, four more are being prepared for transfer to the National Guard, and an additional six are being used for Southwest Asia rotation. The remaining fire units are either manned by German forces or are used for training and maintenance support. One of the nine operational battalions has been sent to South Korea to support U.S. forces there. The PATRIOT force will begin upgrading to the PATRIOT Advanced Capability Level-3 (PAC-3) configuration beginning in FY 1998.

Two THAAD battalions, each with four firing batteries, will be fielded early in the next decade. The THAAD program will also deliver a functional, developmental prototype system at the end of its Demonstration/Validation (Dem/Val) phase. This system, referred to as the THAAD User Operational Evaluation System (UOES), will be used for Engineering and Manufacturing Development (EMD) phase testing and will provide the means for early training. In the event of a national emergency in FY 1997 or later, the UOES could become a deployable prototype system. This system will be based at Fort Bliss, Texas and could be rapidly inserted into any theater using current military transport aircraft.

The MEADS program (formerly Corps SAM) is a multilateral international cooperative program to develop a medium air and missile defense system. The system will support force projection operations from early entry to decisive operations.

Five Joint Tactical Ground Station (JTAGS) units will be fielded starting in FY 1996 to provide in-theater processing of Defense Support Program (DSP) data for warning, alerting, and cueing of

Theater Ballistic Missile (TBM) launches. The JTAGS units will be deployed in pairs during wartime or contingency operations to ensure availability on a continuous basis. The current plan is to forward deploy one section of each detachment during peacetime. The JTAGS is the in-theater element of the United States Space Command (USSPACECOM) Tactical Event System.

The Army force structure includes attack helicopters and the Army Tactical Missile System (ATACMS) which support the joint attack operating pillar.

2.4.2 Navy

The Navy Theater Ballistic Missile Defense (TBMD) program is based on evolving the capabilities of the AEGIS weapon system to support increasing intercept capability against TBMs. The first stage of this evolving capability is called the Navy Area TBMD program. During this stage the AEGIS combat system will be modified to support TBMD and the STANDARD Missile-2 will be modified to the Block IVA TBMD configuration. This area defense program will provide a lower tier or endoatmospheric intercept capability. The second evolutionary stage of the Navy program will build on the AEGIS combat system area defense and develop an exoatmospheric (or upper tier) interceptor to provide theater-wide capability. TBMD capability upgrades will be fully integrated with the AEGIS multi-mission capability in all four pillars of Theater Missile Defense (TMD). The Navy will also work with the Air Force to develop a boost phase intercept capability as described below.

The Navy plans to achieve a sea based area theater ballistic missile defense contingency capability in 1998 with a User Operational Evolution System (UOES) on at least one AEGIS ship. The test and evaluation of the UOES in conjunction with testing at shore engineering support activities will provide significant opportunity for further development and validation of doctrine and tactics in both Navy and joint environments.

The Navy force structure also includes aircraft and ship launched weapons with attendant Battle Management/Command, Control, Communications, Computers and Intelligence (BM/C^4I) which support the joint attack operating pillar.

2.4.3 Air Force

The Air Force, in concert with the component commanders and in accordance with Joint Publication 3-01.5, will focus on attacking theater missiles in the boost phase after launch or while on the ground through attack operations on enemy missile sites and launchers, and on disrupting the enemy's missile operations with an appropriate balance of joint assets. Space support and theater sensor data must meet reduced time lines, with more accurate target detection, identification and tracking data for TBM targets in the air or on the ground. Active defense in the terminal phase and passive defense enable the Joint Task Force to mitigate the destructive potential of theater ballistic missiles that are not destroyed by counterforce and boost phase interceptors.

The Air Force theater structure that will support TMD will primarily be performed with Theater Air Control System (TACS) elements that have been enhanced to meet stringent TMD requirements. These TACS elements include Air Operations Center, Control and Reporting Center, Airborne Warning And Control Systems (AWACS), and Joint Strategic Tactical Airborne Range

System (STARS) to provide BM/C^{4}I for the other pillars. In addition, the Air Force TMD support includes airborne weapons in support of active defense through boost phase intercepts, and F-16s supporting attack operations by engaging threat missile launching systems on the ground.

The Air Force also is responsible for space based launch detection and warning of TBMs. Currently space based ballistic missile launch detection is accomplished by Defense Support Program (DSP) satellites. Fixed and mobile DSP data processing centers transmit launch detection and missile parameter information to the Combat Operations Center at Cheyenne Mountain, Colorado. This information is then evaluated and forwarded to end users such as the National Military Command Center and U.S. forces worldwide. DSP data can also be processed directly in the theater for tactical application and processing by other systems.

2.4.4 Marine Corps

Marine Corps active defense force structure has an evolving TMD capability through modification and upgrade of current weapons systems. Initial operating capability will provide TMD detection and engagement in FY 1996-1997. A full operational capability with improved command and control will be fielded in FY 1999-2000.

Marine TMD active defense force structure consists of the following elements:

- Tactical Air Command Center` (TACC). The battle management and C^2 element; receives, processes and transmits TBM/aircraft targeting information to other elements via digital data communications;
- Tactical Air Operations Module (TAOM). Provides TBM target data to the weapons elements via digital data;
- AN/TPS-59 Radar. Provides surveillance, early warning and weapons cueing for the MAGTF. The upgraded version will detect, track and process TBM targets for the TAOM;
- Air Defense Communications Platform (ADCP). Provides a communications interface from the TPS-59 radar, Tactical Air Operations Center (TAOC) or Joint Tactical Information Distribution System (JTIDS)/Tactical Data Information Link-J (TADIL-J) data network to the HAWK missile system;
- HAWK missile. Acquires, tracks and engages short-range TBM targets.

Marine Corp air capability will also provide attack operations in concert with the other services.

2.4.5 Joint Force Structure

2.4.5.1 Joint Theater Missile Warning Operations

The joint nature of TMD operations is highly evident in the missile detection and warning structure set up to support the theater CINCs. After the Gulf War, all the Services recognized the need to improve missile threat warning to their deployed forces. This need resulted in the creation of

three complementary systems to process tactical warning data quickly in the theater and with improved accuracy. Each of the new systems combines inputs from two or more DSP satellites ("stereo" DSP data) with other sources (e.g., national sensors, radar, intelligence) to refine launch point and missile trajectory. The Tactical Surveillance Demonstration (TSD) was developed cooperatively by the U.S. Army and the U.S. Navy in 1991-92 to do stereo DSP processing. This resulted in a mobile prototype called the Tactical Surveillance Demonstration Enhancement (TSDE), which has been demonstrated successfully in several theaters.

Based on results of TSDE, the JTAGS program was initiated by the Army. JTAGS is a joint interest Army-Navy program for in theater DSP which will be fielded in FY 1996. In addition to supporting TMD operations, JTAGS will produce and distribute information concerning certain aircraft and selected static infrared events for air defense and other applications such as battle damage assessment.

Using TSDE as a starting point, the Air Force developed a prototype for U.S.-based stereo DSP processing, called TALON SHIELD. The fielded capability for TALON SHIELD is designated Attack and Launch Early Reporting To Theater (ALERT) and provides theater commanders with continuous, accurate launch warning and tracking data. A Navy demonstration of related technology, begun as Radiant Ivory, will become operational in FY 1995 as TACDAR (Tactical Data and Related Applications).

Active defense units will use missile position information to cue radars searching for TBMs in flight. Warning information from space based sensors will also be used including launch point and launch time, predicted ground impact point and impact time, missile type, and state vector. Missile position information will improve reaction time and extend the effective battle space of active defense weapon systems. Active defense army units (PATRIOT battalions and THAAD batteries) will receive ALERT/JTAGS data via the Tactical Information Broadcast Service (TIBS) and the joint communications (TADIL-J) net directly at brigade and battalion Tactical Operations Centers (TOCs). Navy units will also receive early earning information via Link 11/16, TIBS, or other broadcast paths. The battalion will pass the information to the fire unit (battery) level to initiate radar search and engagement sequence as appropriate.

Attack operations units will use JTAGS produced launch point and launch time information to plan and execute offensive missions (e.g., air strikes, fire missions) against TBM launchers and infrastructure. Army attack operations units equipped with TIBS receivers will receive their information directly from JTAGS. TIBS receivers will be employed at corps, division, and brigade fire support elements and attack aviation battalion TOCs. An anticipated application of JTAGS information is to cue Joint STARS or other theater sensors with launch point and launch time information. This information may enable these sensors to acquire and track a TBM launcher back to a hidden reloading point, and then pass this new location to attack operations units.

Passive defense warning information will provide launch azimuth, predicted ground impact point, and predicted impact time for selective redistribution. Elements will receive cueing information directly via JTAGS and indirectly via ALERT. Recipients of voice warning messages received directly from the ALERT/JTAGS are expected to retransmit these warnings, filtered to areas of interest when and where possible, to all lower echelons via their own organic networks and sys-

tems. Although warnings by voice messages are expected to predominate in the passive defense arena, some units may also receive data messages and initiate internal warning procedures based on that information.

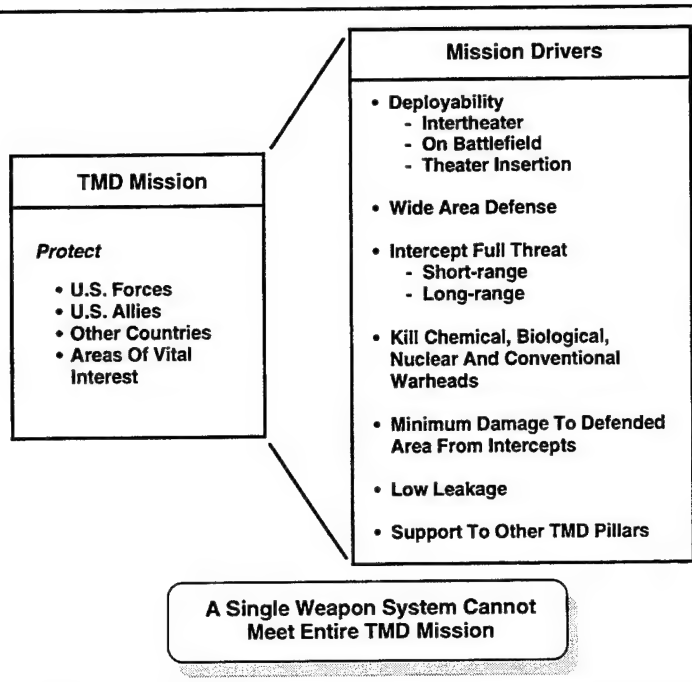
2.4.5.2 Joint TMD Operations

A combination of active defense, attack operations and passive defense, all fully integrated by a joint C^3I architecture, is needed to meet TMD performance requirements. Joint TMD will depend on the coordinated sequential execution of a wide spectrum of tasks by widely dispersed Service and allied elements. The key to successful execution of this complex system will be joint planning, training, communications, and procedures. Intelligence preparation of the battle space, as well as logistics and geographical concerns must be addressed prior to system deployments.

2.5 TMD Active Defense Framework

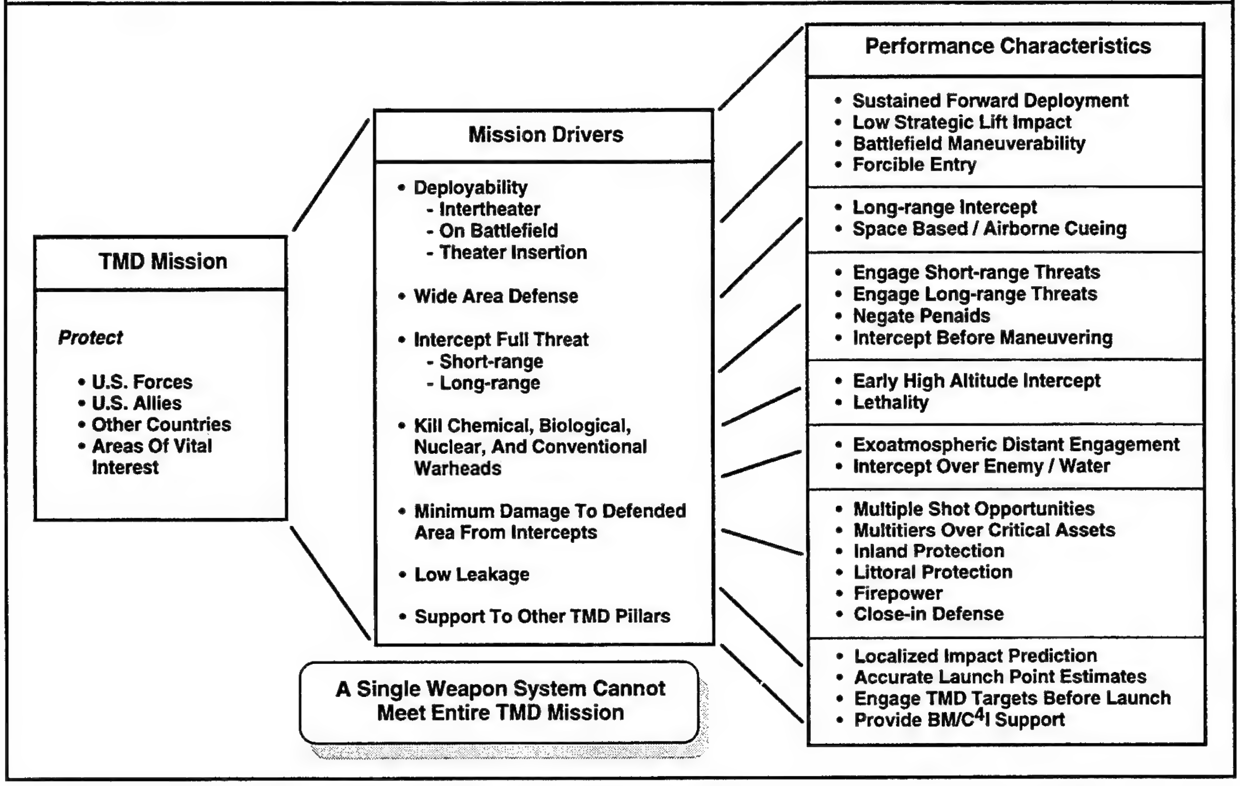
The 1993 Theater Missile Defense Initiative (TMDI) Report to Congress presented a framework and architecture developed from operational and technical attributes. Ballistic Missile Defense Organization (BMDO) continuously evaluates the Theater Missile Defense (TMD) mission, threat characteristics, and doctrine and updates the mission drivers and desired TMD performance characteristics. This continuous process ensures that the framework and architecture meet the TMD system requirements. We modified the framework in FY 1994 to respond to the evolving doctrine. The framework has not changed for FY 1995. The primary conclusion, "a single weapon system cannot meet the entire TMD mission," remains valid. Figure 2-2 shows the TMD mission and resultant mission drivers.

Figure 2-2. TMD Mission Drivers



The mission drivers are used to identify the key performance characteristics of the TMD system. Figure 2-3 shows the resultant performance characteristics.

Figure 2-3. The TMD Performance Characteristics



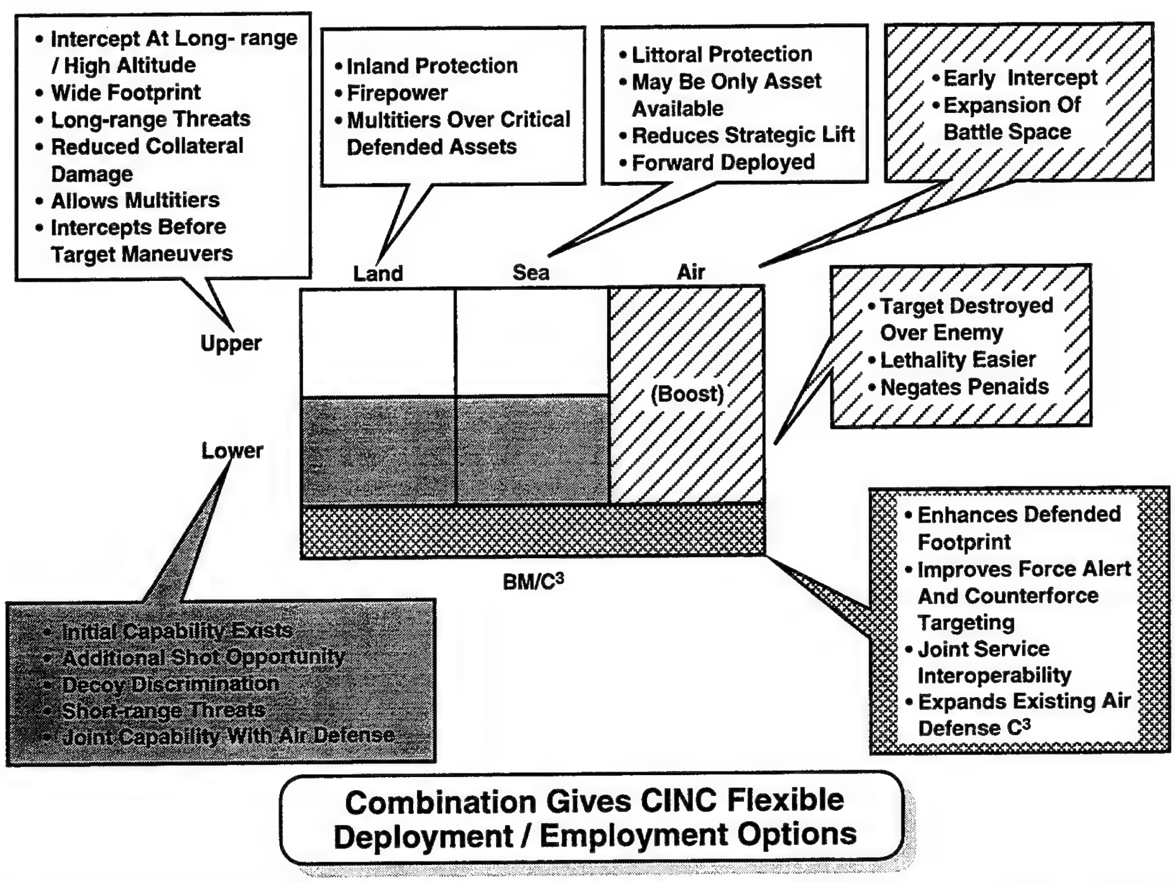
An examination of these characteristics leads to the conclusion that upper and lower tier TMD systems consisting of land, sea, and air forces provide the most effective framework for TMD which is shown in Figure 2-4.

As indicated, Battle Management/Command, Control and Communications (BM/C^3) remains the critical element that ties the other elements together.

2.6 Acquisition Strategy

The Theater Missile Defense (TMD) acquisition strategy has not changed and is still described as three phases. The first phase consists of the aggressive pursuit of near term improvements by enhancing existing systems using low risk, low cost, and quick reaction programs while simultaneously developing and refining TMD concepts of operation and tactics. The second phase employs a prudent acquisition approach to provide a significant core TMD capability. This core capability consists of land based defenses to protect critical assets and to provide theater-wide protection. The core capability also includes a sea based defense to protect U.S. and friendly forces in ports and littoral areas and to support forced entry. A critical element of the core program is to establish an effective and joint Battle Management/Command, Control and Communications (BM/C^3) architecture. In the final phase, advanced concept technology demonstrations and other risk reduction activities are used to develop capabilities that complement the core program with the emphasis on affordability and new technologies. These future capabilities are called "advanced concepts." The TMD acquisition strategy includes the operational employment

Figure 2-4. TMD Active Defense Framework

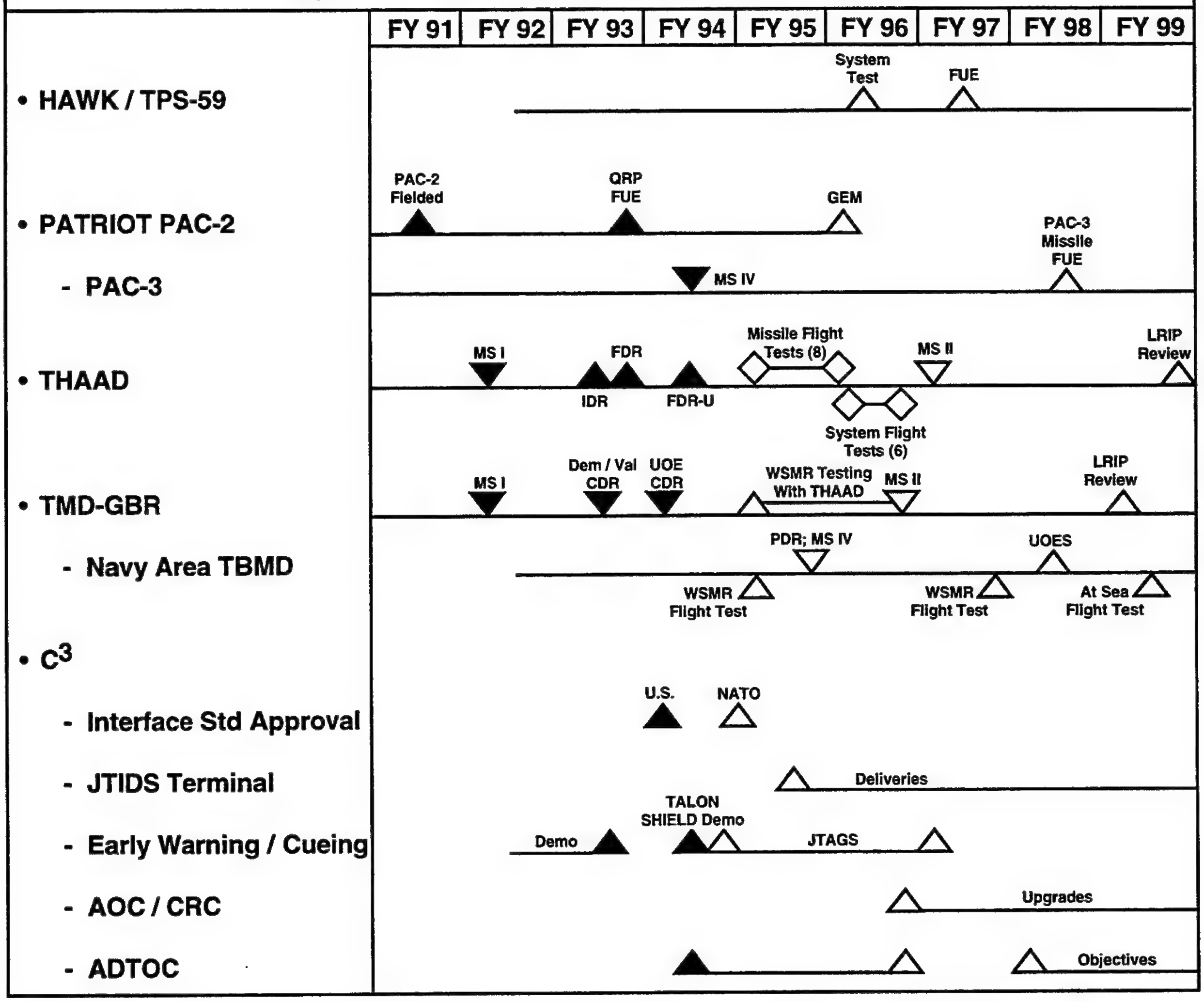


of systems developed during the Demonstration/Validation (Dem/Val) and Engineering and Manufacturing Development (EMD) phases of the acquisition process. These User Operational Evaluation Systems (UOESs) serve four purposes: (1) influence the engineering and manufacturing development program by getting users involved early; (2) provide systems for testing, evaluating, and training as part of the normal acquisition process; (3) refine operational doctrine and organizational structures; and (4) provide a contingency defense capability should the need arise in an emergency prior to production and deployment. The acquisition programs for Theater High Altitude Area Defense (THAAD) and Navy Area Theater Ballistic Missile Defense (TBMD) include provisions for UOESs.

2.7 Master Schedule

Figure 2-5 shows the master schedule for the Theater Missile Defense (TMD). Key milestones are the availability of the User Operational Evaluation Systems (UOESs) for the core program (THAAD and Navy Area TBMD), the initial fielding of PATRIOT Advanced Capability Level-3 (PAC-3), the initial fielding of Theater High Altitude Area Defense (THAAD) and Navy Area Theater Ballistic Missile Defense (TBMD), and the initiation of a major acquisition program for one of the Advanced Concepts. Note that the Near term Improvements program is continuously upgrading fielded systems.

Figure 2-5. TMD Active Defense Master Schedule



2.8 Near Term Improvements

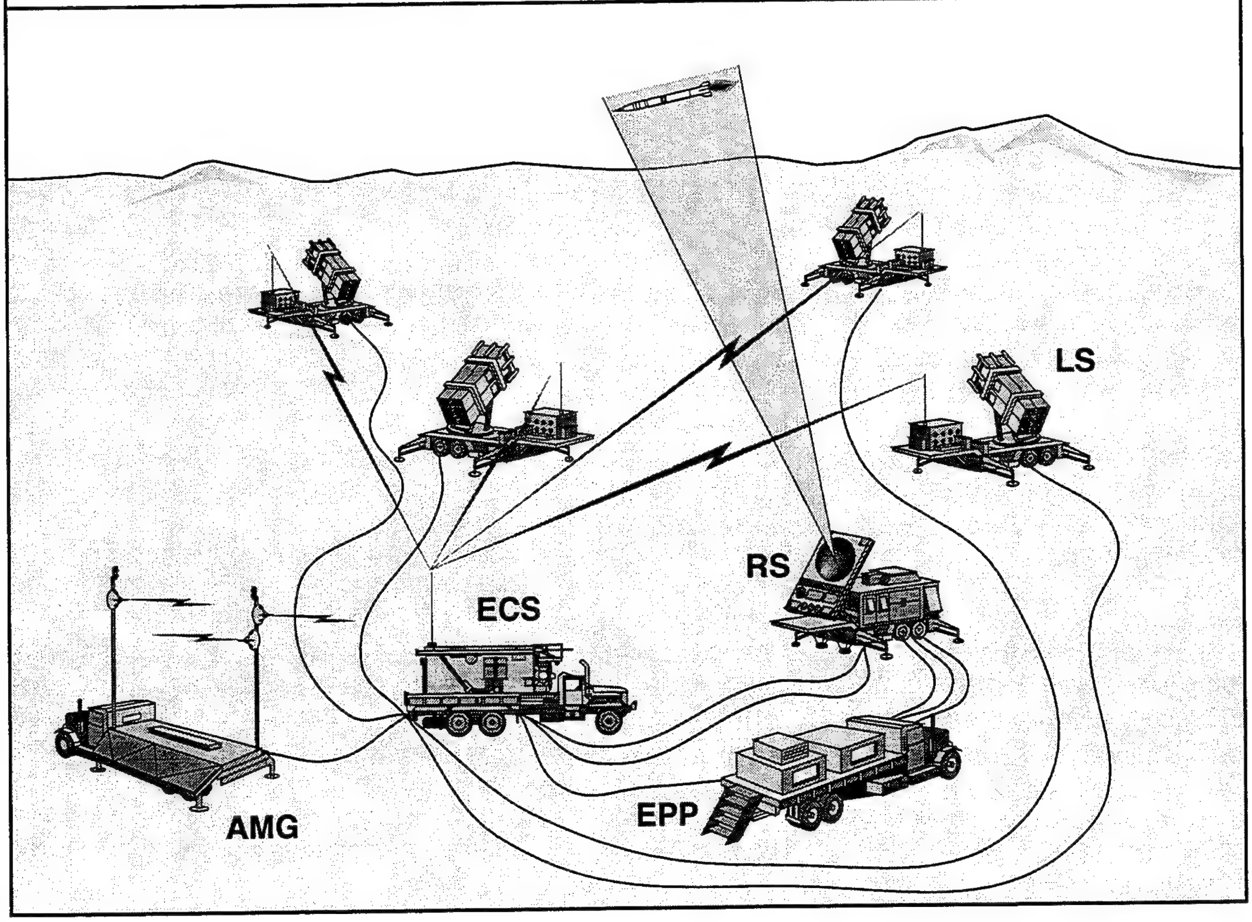
Near term improvements increase existing Theater Missile Defense (TMD) active defense capabilities until the core programs are available at the end of the decade. Included are: PATRIOT Advanced Capability Level-2 (PAC-2) upgrades, TPS-59 radar and HAWK modifications, launch detection improvements, sensor cueing upgrades, and the Commander in Chiefs (CINCs') Assessment Program.

2.8.1 PATRIOT Anti-Tactical Missile Capability

The baseline for PATRIOT is PAC-2. Near term upgrades include the Quick Reaction Program (QRP) and a Guidance Enhancement Missile (GEM) improvement. These upgrades will be followed by a series of upgrades under the PATRIOT Advanced Capability Level-3 Program (PAC-3).

PATRIOT is an air defense guided missile system designed to cope with the air defense threat of the 1990s. The threat is characterized by defense suppression tactics using saturation, maneuver, and electronic countermeasures. The principal element of the PATRIOT organization is the battalion, which consists of up to six firing batteries. Battalions normally deploy at echelons above the corps and as part of the corps air defense artillery brigade. The PATRIOT battery, also referred to as a fire unit, is the smallest element capable of engagement operations. The PATRIOT firing battery, shown in Figure 2-6, includes the fire control section and normally eight Launching Stations (LS) although a battery has the capability to control up to 16 launching stations. The fire control section consists of a Radar Set (RS), Engagement Control Station (ECS), Antenna Mast Group (AMG), and Electric Power Plant (EPP).

Figure 2-6. PATRIOT Firing Battery



The PATRIOT Quick Reaction Program (QRP), instituted in 1991-1992, was designed to identify and quickly field improvements to correct Desert Storm shortcomings. It includes emplacement upgrades for rapid, accurate fire unit emplacement, a capability to control launchers located up to 10 km from the radar, and radar enhancements to improve Theater Ballistic Missile (TBM) detection and increase system survivability. The QRP configuration of PATRIOT is already operational and is deployed in Saudi Arabia.

The Guidance Enhancement Missile (GEM), a companion program to the QRP, includes engineering improvements to the PAC-2 missile to improve effectiveness and lethality, especially against the Desert Storm class of TBM threats. Limited quantities of GEMs will be fielded in

1995 and a total quantity of 345 (180 new and 165 retrofitted) missiles will be procured by the end of FY 1996.

FY 1994 efforts included the following accomplishments:

- Continued fielding QRP battalions;
- 39 of 116 radar kits delivered;
- 236 of 553 launcher modification kits delivered;
- Conducted one missile flight test;
- Conducted GEM production review.

Work planned for FY 1995 includes:

- Complete QRP fielding;
- Complete final GEM flight test;
- Begin delivery of GEM missiles.

Work planned for FY 1996 includes:

- Continue delivery of GEM missiles.

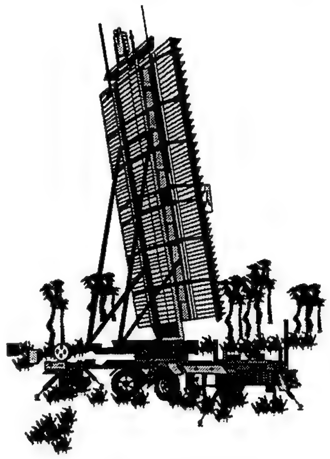
2.8.2 TPS-59 Radar and HAWK Modifications

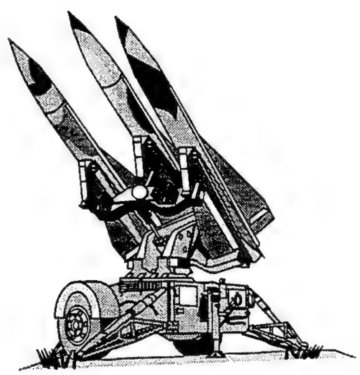
TPS-59 radar and HAWK weapon system improvements will provide a TMD capability for U.S. Marine Corps operations. This Marine Corps TMD initiative is jointly funded with Ballistic Missile Defense Organization (BMDO) and will yield a low risk, near term capability for expeditionary forces against short-range ballistic missiles. The program consists of modifying the TPS-59 long-range air surveillance radar and the HAWK weapon system to allow detection, tracking, and engagement of short-range TBMs. The program will also provide a communications interface by developing an Air Defense Communications Platform (ADCP).

Modifications to the TMD mode of the TPS-59 radar, summarized in Figure 2-7, will result in TBM target detection ranges out to 400 nautical miles and 500,000 feet in altitude. Technical, developmental, and operational testing is scheduled for FY 1996 with first units equipped in early FY 1997.

The HAWK weapon system modifications include upgrades to the battery command post and improvements to the HAWK missile that will result in an "improved lethality missile." The modified HAWK battery command post will process cueing data to control the high-power illuminator radar. The improved lethality missile will incorporate fuse and warhead improvements. Improved lethality missiles have been transferred from the Army to the Marine Corps and additional missiles will be procured by the end of FY 1996. Production of the battery command post modification kits will begin in FY 1995. The installation of all battery command post modifications will be completed by the end of FY 1996.

Figure 2-7. TPS-59 Radar And HAWK





BMDO Funded

- **Upgrade TPS-59 To Provide Enhanced TBM Surveillance And Tracking Capability**
- **Air Defense Command Post To Act As A Node For Tactical Nets**
  - **Make TPS-59 Data Available On A JTIDS Net**
- **Modify Battery Command Post To Accept TPS-59 Data, For Acquisition By HAWK Illuminator Radar**
- **Upgrade HAWK Missile Fuze And Warhead For TBM Engagements**

USMC Funded

- **Upgrade Of HAWK Launcher To Interface With Digital Missiles**
- **Upgrade Of HAWK Launcher To Increase Mobility**

The ADCP will convert TPS-59 data messages and Tactical Data Information Link-J (TADIL-J) formatted messages into the intra-battery data link formats required by the HAWK weapon system. The ADCP will also transmit TADIL-J formatted messages to other theater sensors. This communications interface is currently in development and initial production will begin in FY 1996.

A major accomplishment in FY 1994 was the integrated test of the HAWK TMD capability which verified the operation of the AN/TPS-59, data link, battery command post, and improved lethality missile. Two Lance missiles were successfully intercepted and destroyed by the improved lethality missile during this test.

FY 1994 efforts included the following accomplishments:

- Approved AN/TPS-59 baseline design;
- Approved ADCP baseline design;
- Conducted first integrated test of HAWK TMD capability verifying the operation of the AN/TPS-59, data link, battery command post, and improved lethality missile.

Work planned for FY 1995 includes:

- Complete AN/TPS-59 system integration effort;
- Initiate AN/TPS-59 contractor's developmental tests;
- Initiate ADCP integration and testing.

Work planned for FY 1996 includes:

- Complete integration and testing of AN/TPS-59, the ADCP, and the HAWK system modifications;
- Begin production of the AN/TPS-59 modification and the ADCP;
- Complete HAWK battery command post modification kit production and installation.

2.8.3 Launch Detection

Launch detection improvements address shortcomings from Desert Storm. These improvements provide earlier targeting opportunities for active defense elements and earlier warning for passive defense. Counterforce strikes may also benefit from better launch point estimates. The complementary programs that provide these improvements are: the Air Force's Attack and Launch Early Reporting to Theater (ALERT) program, the Navy's Tactical Detection and Reporting (TACDAR) program, and the Army-Navy sponsored Joint Tactical Ground Station (JTAGS) program. The three programs complement each other in that they draw from various intelligence sources, they provide continuity of operations, they allow access to alternate warning networks, and they can share coverage responsibilities. The complementary capabilities of these programs are integrated within the United States Space Command (USSPACECOM) Tactical Event System (TES). TES will meet the TMD requirements for launch detection and warning as tactical processors mature from demonstrations to full operational capability.

These launch detection programs will interface with the Tactical and Related Applications (TRAP) Data Dissemination System (TDDS), Tactical Information Broadcast Service (TIBS), and other tactical data networks to provide a robust capability for all Service users. TALON SHIELD is a BMDO sponsored data fusion program that processes multi-sensor Defense Support Program (DSP) and classified sensor data at a central location at Falcon AFB, Colorado. The initial operational capability for TALON SHIELD is designated ALERT and provides theater commanders with continuous, accurate launch warning and tracking data. TACDAR processes classified data from a unique sensor. It also provides the data to TALON SHIELD for fusion with data from other sensor assets. The JTAGS program is a tactical transportable stereo DSP ground station for use in theater. JTAGS processes DSP sensor data from up to three DSP sources. The JTAGS program utilizes ruggedized hardware and software developed by the Tactical Surveillance Demonstration (TSD) and the BMDO, Army and Navy sponsored Tactical Surveillance Demonstration Enhancement (TSDE) programs.

Technology demonstrations and operational testing will continue throughout FY 1995. Significant ALERT tests include demonstration of multiple satellite data fusion against cooperative launches and targets of opportunity. The Army will conduct JTAGS Engineering and Manufactur-

ing Development (EMD) phase technical and operational tests during FY 1995. The Air Force will conduct technology demonstrations for the Space and Missile Tracking System (SMTS) flight demonstration system and continue development during FY 1995.

FY 1994 efforts included the following accomplishments:

- Completed TALON SHIELD/ALERT developmental tests with DSP data and began TALON SHIELD/ALERT operations;
- Reported tactical ballistic missile launches in Yemen, Korea, and other locations. Provided rapid, accurate launch point and impact point estimates and tracking data to operational commands via Joint Tactical Information Distribution System (JTIDS);
- Deployed the JTAGS transportable prototype outside of the continental U.S. in support of contingency operations;
- Began the EMD phase of JTAGS by successful completion of Milestone II (MS II) and award of the EMD contract.

Work planned for FY 1995 includes:

- Expand ALERT capabilities to fuse classified sensor data with DSP sensor data;
- Demonstrate improved ALERT launch point and impact point estimation;
- Procure two JTAGS engineering and manufacturing development units and conduct developmental and operational testing.

Work planned for FY 1996 includes:

- Complete integration of a classified suite of surveillance sensors;
- Demonstrate improved data fusion from multiple satellite sensors;
- Field JTAGS units.

2.8.4 Sensor Cueing

Sensor cueing enhances the detection of targets by fire control radar systems. This enhancement results from reduced radar loading and extended target acquisition range. Radar loading is reduced during TBM detection and tracking by decreasing the radar's search volume. Extending the target acquisition range eliminates the radar as the limiting factor in defended area footprints. This increase in range is particularly important in non-benign environments, i.e., multi-target, electronic countermeasures, and inclement weather. Additionally, improved beam scheduling provides target acquisition in non-benign environments while reducing the system's vulnerability to saturation raids and to anti-radiation missiles.

Sensor cueing efforts include tactical cueing and netting demonstrations. TMD weapons systems,

such as PATRIOT or Theater High Altitude Air Defense (THAAD), are cued by tactical systems and sensors such as JTAGS, AEGIS SPY-1 radar, or TPS-59. Other sensor efforts include tactical processing and application of space sensor data in the TALON SHIELD project and airborne sensor technology development. Sensor cueing efforts will provide operational PATRIOT cueing software during FY 1996.

The Extended Airborne Global Launch Evaluator (EAGLE) will provide the capability to acquire and track theater ballistic missiles during the late boost and midcourse phase. EAGLE is a combined infrared and laser system designed to detect and track ballistic missiles during boost and post boost phases. Infrared detections will cue the laser tracking system and on board processors will compute launch point estimates, impact point prediction, and threat position and velocity messages for transmission via a joint data link to command and control and fire control centers. The EAGLE Program will enter Demonstration and Validation (Dem/Val) in FY 1995 with the goal of flying a prototype in FY 1997.

FY 1994 efforts included the following accomplishments:

- Developed tactical cueing program plan;
- Defined EAGLE operational requirements.

Work planned for FY 1995 includes:

- Conduct JTAGS tactical cueing demonstration;
- Award contract for EAGLE prototype sensor design, development, fabrication, integration, installation, test and evaluation, and demonstration aboard an Air Force Airborne Warning and Control System (AWACS) test aircraft;
- Negotiate EAGLE foreign participation.

Work planned for FY 1996 includes:

- Conduct EAGLE component and subsystem ground and airborne technical development and acceptance testing;
- Conduct EAGLE analysis, simulation, and Hardware-In-The-Loop (HITL) tests;
- Conduct PATRIOT/JTAGS operational cueing demonstration.

2.8.5 Commander In Chiefs' (CINCs') Assessment Program

The CINCs' TMD Assessment Program enhances the communication between BMDO as the developer and the war fighting CINC as the ultimate user of TMD systems. It provides a vehicle for the CINCs to assess their TMD capabilities and shortfalls so that they may refine and articulate their TMD requirements. Additionally, this program furthers the refinement of TMD concepts of operation and doctrine as part of the CINCs and Joint Staff overall theater operations plans.

Annually, representatives from the CINC staffs participate in a workshop where developers and the doctrine community brief the latest developments in their respective areas. The CINCs then develop prioritized goals based upon their past TMD experience and promising new technological and doctrinal developments. Working with BMDO, these goals are then translated into an assessment plan for the succeeding two years. The assessments are overlaid on established CINC sponsored exercises to ensure that the TMD capabilities are evaluated in the context of a full spectrum of joint force operations.

The assessments provide operational data directly to the developer, assist the CINCs in updating their integrated priority list and operational requirements document, and permit the formulation of lessons learned that are entered in the Joint Lessons Learned data base maintained by the Joint Staff. These lessons learned support development and refinement of TMD concepts of operation and joint and Service doctrine.

The purposes of the CINCs' TMD Assessment Program are:

- Improve current TMD capabilities;
- Explore new concepts and technology;
- Collect operational data;
- Make TMD part of everyday operations;
- Capture lessons learned to modify and develop operational requirements documents and doctrinal publications;
- Test Command, Control, Communications and Intelligence (C^3I) capabilities, procedures, and interoperability.

FY 1994 efforts included the following accomplishments:

- Supported United States European Command (USEUCOM) joint project Optic Needle, United States Central Command (USCENTCOM) joint project Optic Cobra, and United States Forces Korea (USFK) joint project Ornate Impact including GLOBAL 94;
- Supported Kitty Hawk Battle Group TMD exercise, and United States Atlantic Command (USACOM) TMD exercise with the EISENHOWER Battle Group.

Work planned for FY 1995 includes:

- Support USEUCOM joint project Optic Needle, USCENTCOM joint project Optic Cobra, and USFK joint project Ornate Impact;
- Support USACOM TMD exercises;
- Conduct theater and strategic war gaming, including GLOBAL 95.

Work planned for FY 1996 includes:

- Support USEUCOM joint project Optic Needle, USCENTCOM joint project Optic Cobra, and USFK joint project Ornate Impact;
- Support USACOM TMD exercises and United States Pacific Command (USPACOM) TMD exercises;
- Conduct theater and strategic war gaming, including GLOBAL 96.

2.9 Core Programs

The three core programs are: PATRIOT Advanced Capability Level-3 (PAC-3), the Theater High Altitude Area Defense (THAAD) system, and Navy Area Theater Ballistic Missile Defense (TBMD). The PAC-3 includes a new, highly lethal, Hit-To-Kill (HTK) interceptor and improvements in radar capability. The THAAD system, which includes the Theater Missile Defense-Ground based Radar (TMD-GBR), also incorporates a HTK missile and adds a capability against longer range threats. This upper tier capability provides wide area protection of highly dispersed assets and allows multiple engagements of each target ensuring less leakage. Navy Area TBMD includes improvements to the AEGIS combat system SPY-1 radar, the weapon control system, and the command and direction system. It also adds a Theater Ballistic Missile (TBM) capability to the STANDARD missile through the use of a blast fragmentation warhead that is expected to be lethal against cruise missiles as well as the majority of TBMs. Navy Area TBMD aids deployability by providing a global presence, supporting forced entry, and protecting insertion forces. Figure 2-8 shows the core programs inserted into the TMD active defense framework. The following sections discuss the status of the core programs.

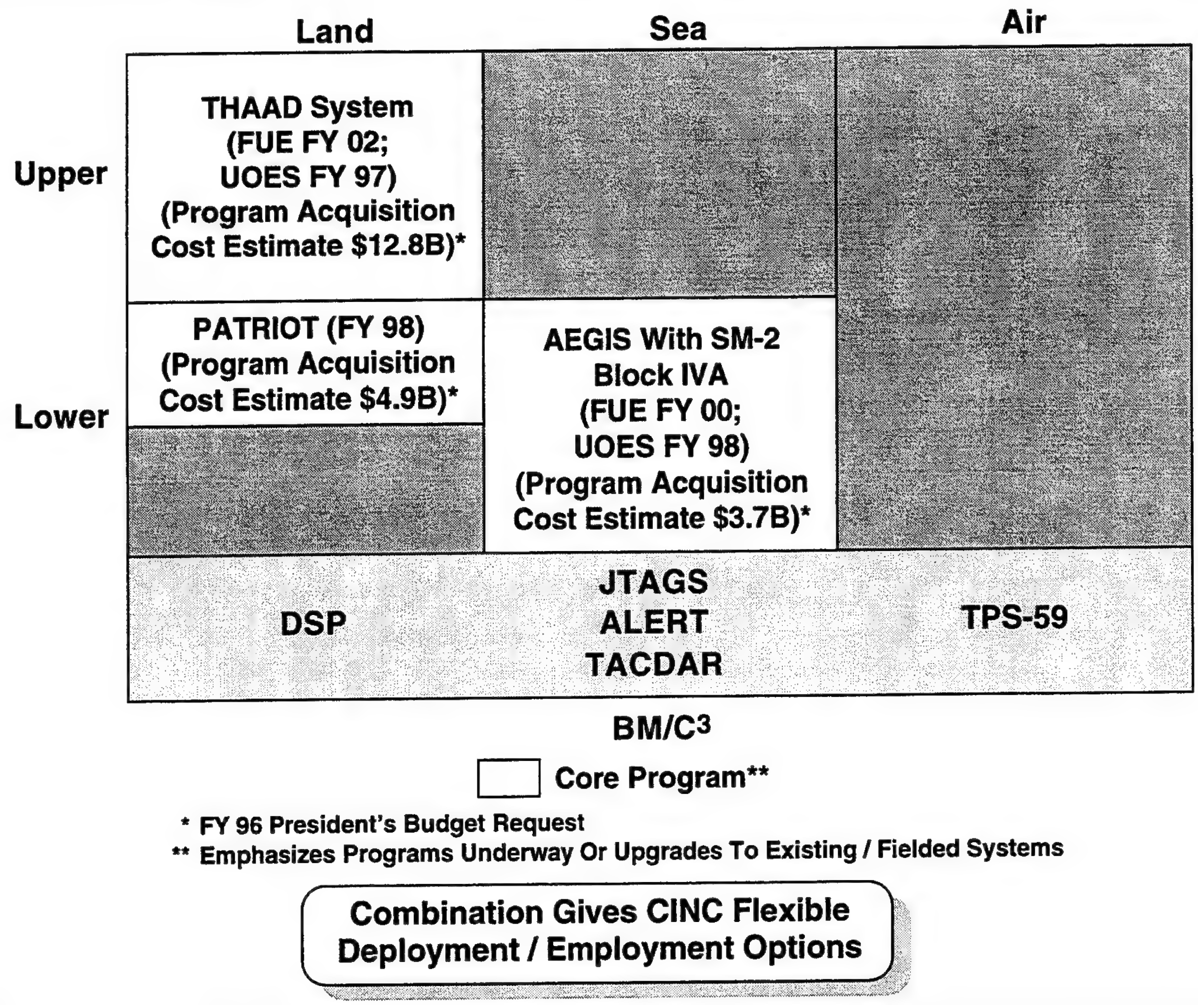
2.9.1 PATRIOT Advanced Capability Level-3 (PAC-3)

The PAC-3 program, which will improve the current PATRIOT Advanced Capability Level-2 (PAC-2) system through a series of upgrades to the PATRIOT radar and the selection of Extended Range Intercept Technology (ERINT) missile, will satisfy the PAC-3 requirement to increase system battle space and lethality capabilities. The planned radar enhancements will increase detection range; improve target Classification, Discrimination, and Identification (CDI); improve the engagement of targets with reduced radar signatures; increase target handling capability; increase firepower; and enhance survivability. PAC-3 is required to counter both tactical ballistic missiles and cruise missiles.

These upgrades will be implemented through a series of fielded configurations. Configuration One consists of an expanded weapons control computer, optical disk, and embedded data recorder and the pulse doppler processor. Software associated with these hardware improvements along with other software improvements will be fielded as part of Configuration One. Configuration One is currently in production with the first unit equipped in FY 1995.

Configuration Two consists of Communications Enhancements Phase I; two software improvements — the counter anti-radiation missile and CDI Phase I; and implementation, via software, of the full capability of the Radar Enhancements Phase II hardware. Configuration Two will be implemented by the Post Deployment Build-4 software.

Figure 2-8. TMD Active Defense Framework Core Programs



Configuration Three consists of eight major improvements. The five hardware improvements are: the PAC-3 missile, Radar Enhancements Phase III, CDI Phase III, Remote Launch Phase III, and Communications Enhancements Phase II. The three software upgrades consist of PATRIOT/ THAAD Interoperability, Joint Theater Missile Defense (TMD) Interoperability, and Launch Point Determination. Configuration Three will be implemented by Post Deployment Build-5 software.

Two missiles were considered for the PAC-3 program: the Multimode Missile (MMM) and ERINT missile. In the second quarter of FY 1994 the Army selected the ERINT missile. The ERINT missile is a hit-to-kill interceptor that provides active defense against TBMs and air breathing threats. It uses an on board active Ka-band seeker, aerodynamic control vanes, and impulse attitude control thrusters to provide the rapid maneuvering necessary for a hit-to-kill intercept. Hit-to-kill technology, as opposed to blast fragmentation, will increase lethality against mass destruction warheads.

Developmental and operational test and evaluation will occur between the fourth quarter of FY 1996 and the fourth quarter of FY 1998. PAC-3 fielding will begin in the fourth quarter of FY

1998.

FY 1994 efforts included the following accomplishments:

- Completed ERINT and Multimode Missile Demonstration and Validation (Dem/Val) flight test programs;
- Completed Radar Enhancements Phase III subsystem testing and integration;
- Completed testing of PATRIOT/ERINT Demonstration and Validation (Dem/Val) hardware and software integration;
- Delivered Dem/Val seeker to support Missile Command Hardware-In-The-Loop (HWIL) testing.

Work planned for FY 1995 includes:

- Initiate PAC-3 missile Engineering and Manufacturing Development (EMD) and EMD Integration contracts;
- Conduct software specification, preliminary design, and critical design reviews to complete PAC-3 missile design;
- Begin PAC-3 missile hardware procurement/fabrication;
- Provide hardware to support sled tests and hypervelocity gun tests to support lethality reporting requirements and live-fire test preparations.

Work planned for FY 1996 includes:

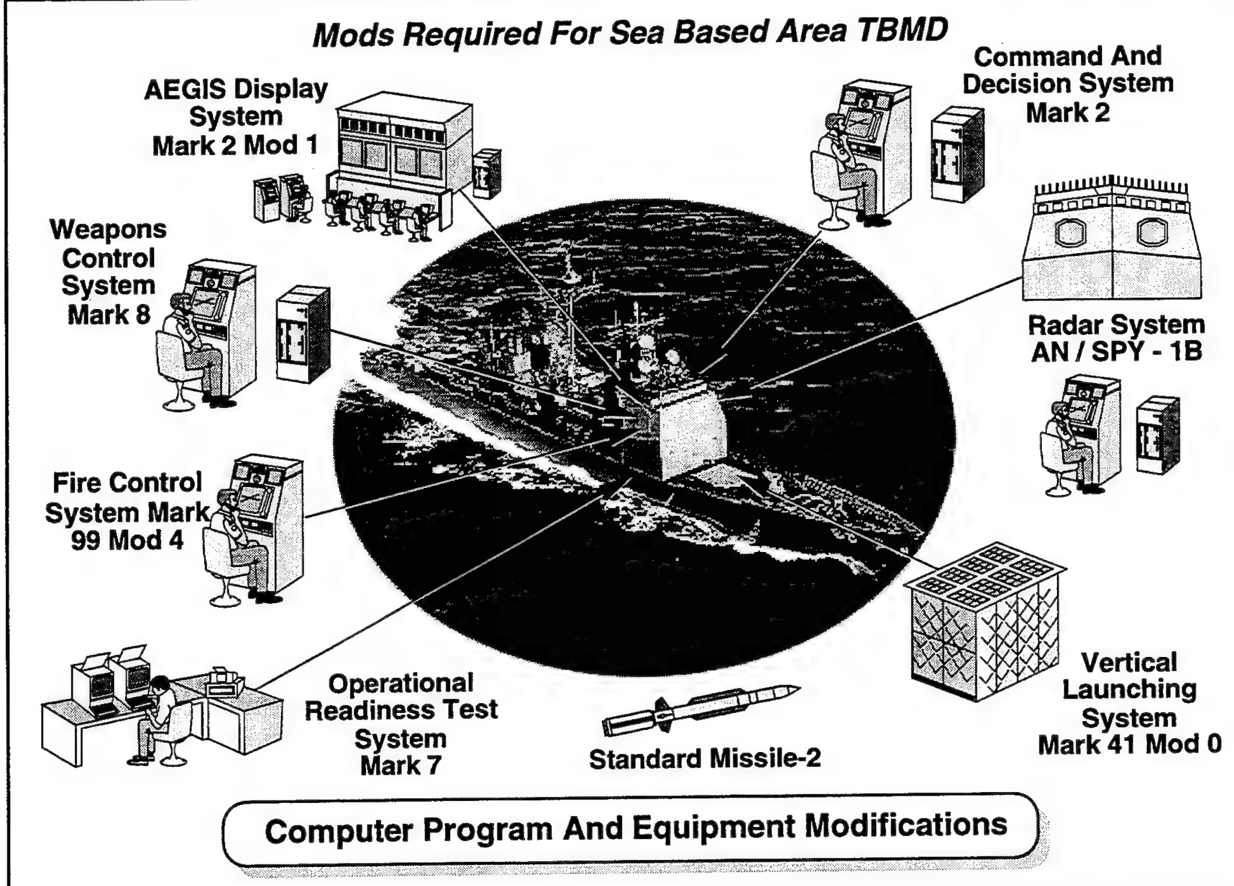
- Deliver EMD brass board seeker to support Missile Command HWIL test and support test reviews;
- Complete integration and testing of CDI Phase III and conduct production design review;
- Begin formal flight testing and EMD target and test support.

2.9.2 Navy Area TBMD

The goal of this Navy effort is to provide a sea based area theater ballistic missile defense capability building on the existing AEGIS system, which is shown in Figure 2-9.

This effort focuses on modifying the AEGIS combat system to enable TBM detection, tracking, and engagement by a modified Standard Missile SM-2 Block IV. The SPY-1 radar computer programs and equipment will be modified to allow search at higher elevations and longer ranges in order to detect TBMs and to maintain track on the ballistic targets. The weapon control system will predict intercept points and engagement boundaries for ballistic targets, initialize missiles, conduct firings, and provide uplink commands as the missile flies to intercept the TBM. AEGIS

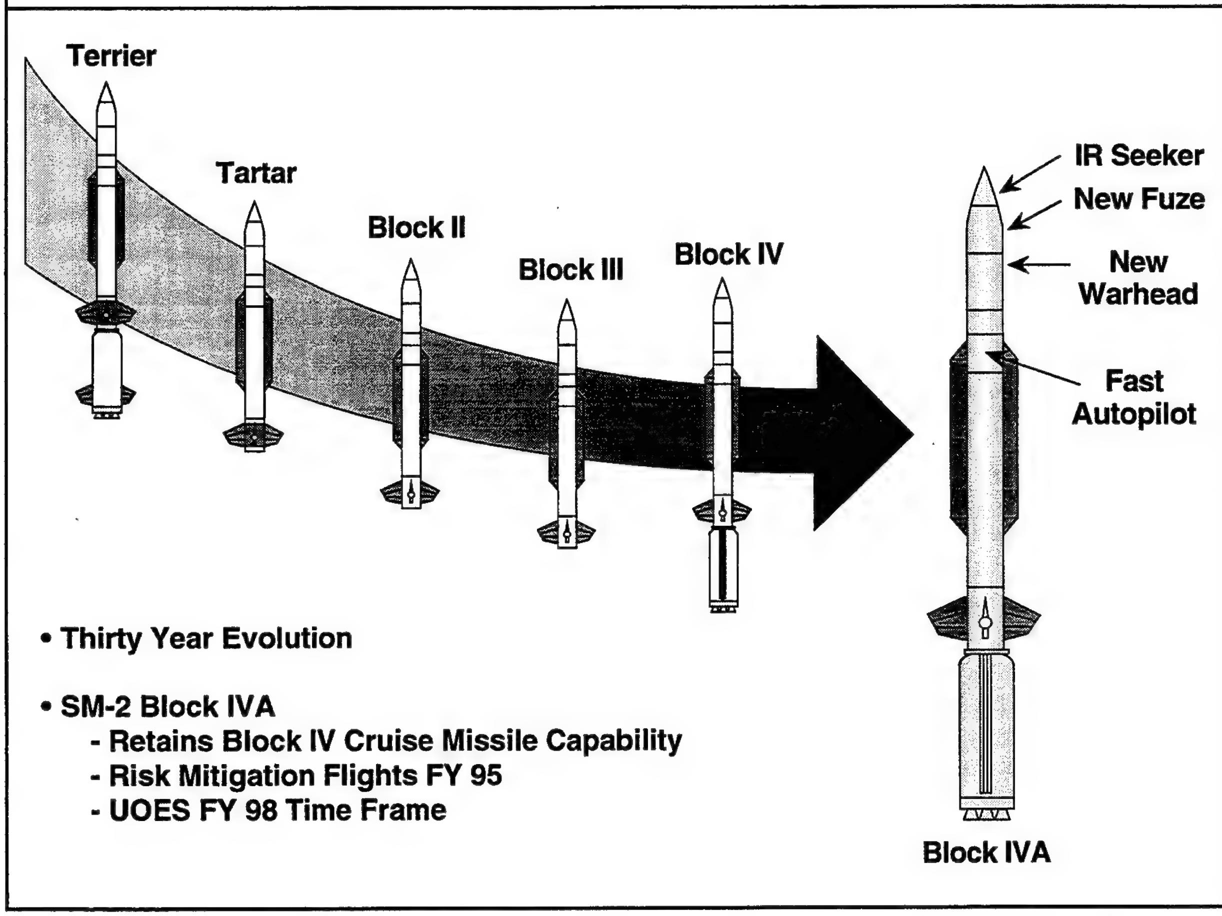
Figure 2-9. AEGIS Weapon System



displays and the on board command and decision system computer programs and equipment will be modified to display TBM tracks and engagements and to interface with other elements of the combat system as well as with off ship sensors (e.g., Defense Support Program (DSP)).

The SM-2 Block IV, which has successfully completed an operational assessment and will be commencing Low Rate Initial Production (LRIP), is the basis for the initial sea based TBMD capability that focuses on the more numerous, shorter range, lower apogee threats. As noted in Figure 2-10, changes to the baseline SM-2 Block IV include warhead, seeker, and fuze modifications to improve intercept performance against ballistic missiles within the atmosphere. Warhead modifications will capitalize on engineering analysis and design efforts already completed for the PATRIOT missile. An infrared seeker will be used to reduce miss distance. The fuze will be improved to ensure proper performance in the high closing rate missile-to-missile encounters. The modified SM-2 Block IV (designated SM-2 Block IVA) is being designed to retain capability against antiship cruise missiles while providing significant capability to defeat the majority of the world's tactical ballistic missiles. Future efforts will focus on improving the guidance of the Block IVA to effect increased lethality against emerging threats including chemical submunitions and other weapons of mass destruction. The August 1994 Defense Acquisition Board review of Navy TBMD endorsed this evolutionary approach and approved risk reduction activities leading to a Milestone IV Defense Acquisition Board in FY 1996.

Figure 2-10. Standard Missile 2 Modifications



In addition to the early risk reduction test missiles planned to support testing in 1995, 10 missiles will be procured for developmental tests at White Sands Missile Range (WSMR) and 35 missiles will be procured for use with the AEGIS User Operational Evaluation System (UOES) to provide a mid-decade contingency capability. Low rate initial production (LRIP) procurement beginning in 1998 will make approxiamately 70 missiles available in 2000.

The test and evaluation program for Navy Area TBMD is an outgrowth of almost 20 years of computer program development and management, missile development, and AEGIS weapon system engineering. It includes early missile hardware integration and flight test, infrared seeker wind tunnel and sled testing, warhead development using lessons learned from PATRIOT, early at-sea testing of prototypical computer programs, and extensive land based development of AEGIS weapon system computer programs and equipment at the Combat System Engineering Development Site (CSEDS) in Moorestown, New Jersey.

Early flight tests are planned starting in FY 1995, first at the White Sands Missile Range, and then on an operational AEGIS ship with supporting computer programs. Additional at-sea testing will include multiple engagement scenarios, electronic countermeasures, and other measures designed to rigorously test the robustness of the system. The first fleet unit will receive operational SM-2 Block IVA interceptors and AEGIS TBMD tactical computer programs in 2000.

FY 1994 efforts included the following accomplishments:

- Demonstrated AEGIS cueing to PATRIOT system in consonance with the Joint Air Defense Operations (JADO)/Joint Engagement Zone (JEZ) event, a joint air defense exercise including air, sea, and land based units;
- Continued development/design of SM-2 Block IV modifications to provide the capability to intercept TBMs;
- Initiated procurement of target missiles.

Work planned for FY 1995 includes:

- Continue design of initial AEGIS combat system computer program modifications to enable TBMD detection, tracking and weapon processing to support an SM-2 missile with TBMD capability;
- Conduct land based and at-sea experiments to demonstrate automated acceptance of long-range (off ship) cueing and SPY radar acquisition using off ship cueing sources such as external sensors, land based radars, and other ship radars;
- Continue design and integration for SM-2 Block IVA missile and fabricate risk reduction flight test missiles;
- Procure target missiles.

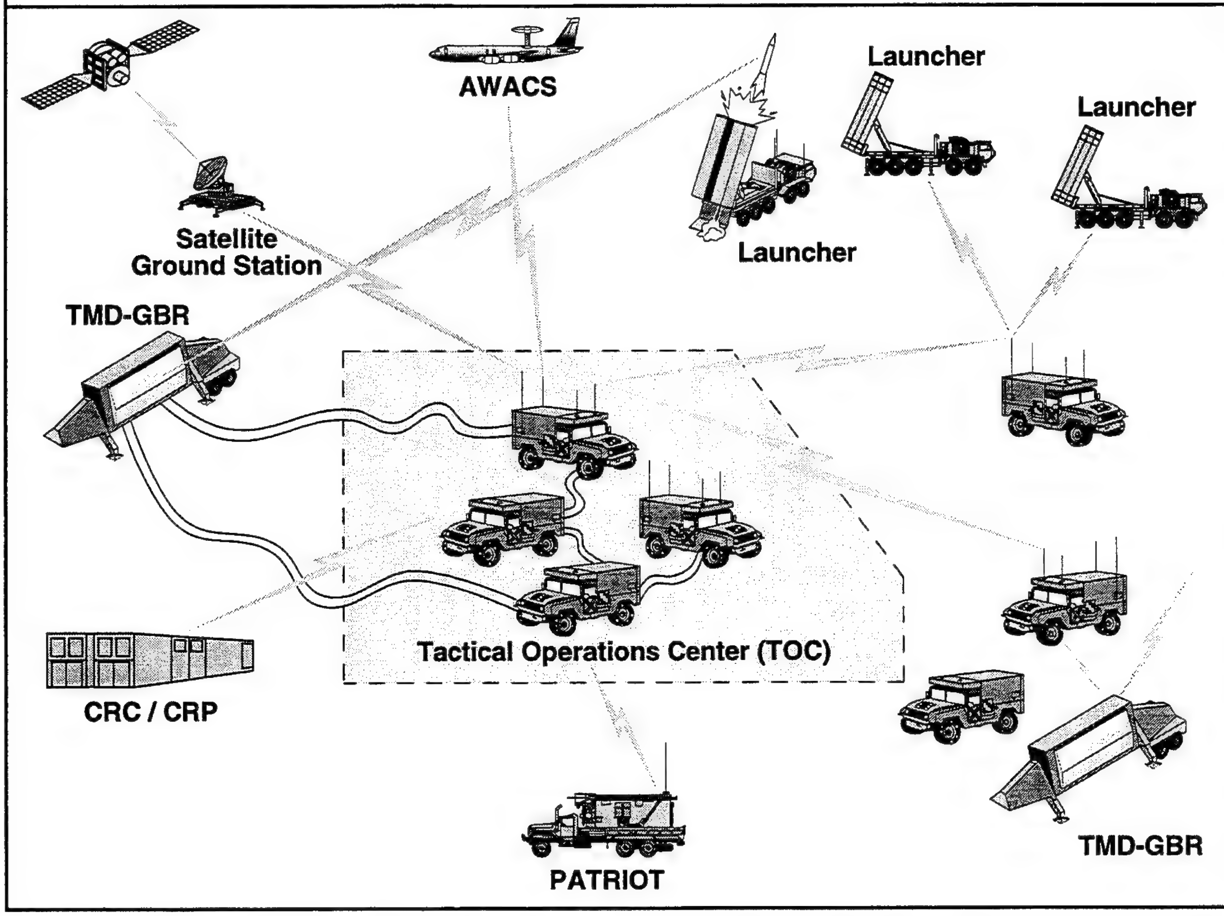
Work planned for FY 1996 includes:

- Conduct AEGIS weapon system TBMD system design review and preliminary design review;
- Complete Navy TBMD Cost and Operational Effectiveness Analysis;
- Conduct risk reduction flight tests;
- Conduct Milestone IV Defense Acquisition Board;
- Procure AEGIS combat system modifications for ships and development sites, and procure support/training equipment for shore facilities.

2.9.3 The THAAD System

The THAAD system, shown in Figure 2-11, consists of the THAAD weapon system and the Theater Missile Defense-Ground based Radar (TMD-GBR) surveillance radar system. The THAAD system comprises the upper tier of a two tiered, ground based defense against TBMs. This system will provide broad surveillance and a large intercept envelope to defeat tactical missile threats directed against wide areas, dispersed assets, and strategic assets such as population centers and industrial facilities. THAAD will engage at high altitudes to minimize damage caused by debris and chemical/nuclear munitions. The combination of high altitude and long-range intercept capability may provide multiple engagement, Shoot-Look-Shoot (SLS) opportunities. The system will be interoperable with other U.S. air defense systems.

Figure 2-11. The THAAD System



The THAAD weapon system includes missiles, launchers, radar, Command Control, Communications and Intelligence (C^3I) units, and ground support equipment. The system will be C-130/C-141 aircraft transportable. The THAAD C^3I units will be compatible with the Air Defense Tactical Operations Center to enable communication with higher and lower echelons.

The THAAD missile is a single stage, solid fuel missile. The missile employs thrust vector technology and a divert and attitude control system. Predicted intercept point and guidance presets are provided by the TMD-GBR to the missile prior to launch. The THAAD missile receives in-flight updates including a target object map for target designation. Terminal guidance data is provided by an infrared seeker looking through a side mounted, uncooled window. The seeker window is protected by a shroud which separates prior to terminal homing. The THAAD missile kill vehicle exhibits enhanced lethality by destroying incoming warheads utilizing kinetic energy impact (Hit-To-Kill). It is capable of both endo- and exoatmospheric intercepts.

The THAAD launcher contains a missile round pallet mounted on a modified U.S. Army palletized loading system truck. Primary power to the launcher is supplied by lead acid batteries that are automatically recharged by a quiet tactical generator. Launch position is determined by the global positioning system and the launch azimuth by a direction reference unit.

The C^3I system is designed to control automated TBM acquisition and identification, track data

processing and dissemination, weapon assignment, engagement monitoring, and sensor operation. The C^3I equipment is configured into the standard integrated command post shelter mounted on a highly mobile, multipurpose wheeled vehicle. The netted, distributed, and replicated command and control architecture allows maximum flexibility for operations at the battalion or battery level.

The primary THAAD sensor is the TMD-GBR. It uses state-of-the-art radar technology and provides theater-wide surveillance, discrimination, and fire control for the weapon system. It consists of five major elements: a mobile, single faced, phased array antenna unit utilizing solid-state transmit/receive modules and separate power generation, system cooling, electronic equipment control, and operations control units. The radar operates in the X-band and provides early warning of threat TBM launches by detecting and acquiring targets at very long ranges using autonomous horizon fence and volume search acquisition modes. The radar performs classification and discrimination to categorize the target type and identify the reentry vehicle. The radar maintains track on the target and provides in-flight updates to the missile prior to intercept. The TMD-GBR provides the critical data to allow the THAAD system to perform kill assessment which supports the decision to commit additional interceptors or to cue lower tier systems such as PATRIOT and the AEGIS weapon system.

The THAAD Dem/Val program includes a comprehensive, integrated, ground and flight test schedule to demonstrate sufficient design maturity to enter EMD and to verify that the deployable prototype UOES has operational capability. The test program initially focuses on computer simulation, early breadboard and brass board hardware, and piece part and component developmental testing. This testing evolves into subsystem, system environment, and functional demonstrations, leading into ground and flight system interface and integration tests.

The THAAD test program will ensure that all critical design and performance issues are resolved early and that the THAAD system will meet operational and functional requirements. The centerpiece of the THAAD test program will be the flight test program at White Sands Missile Range. The THAAD system began flight tests with a successful flight at White Sands Missile Range on 21 April 1995. The 14 missile flight and system tests will incrementally demonstrate increased performance capability by integrated missile, launcher, radar, and C^3I systems.

The TMD-GBR Dem/Val test program consists of two phases. The first phase consists of contractor in plant testing and integration. The second phase consists of government integration and flight test verification activities at White Sands Missile Range.

In addition to the Dem/Val radar unit, two TMD-GBR UOES units will be developed to support the THAAD UOES. These UOES versions of the TMD-GBR will be deployable and available to support THAAD interceptor testing beginning October 1995 and continuing to April 1996. The long-range plan is to begin fielding THAAD in FY 2002.

FY 1994 efforts included the following accomplishments:

- Completed delivery of the Dem/Val interim launcher to White Sands Missile Range;
- Completed delivery of the initial palletized loading system truck and Battle Manage-

ment/Command , Control, Communications and Intelligence (BM/C^3I) shelters to the contractor;

- Completed objective system and UOES final design reviews;
- Completed guidance and control testing;
- Conducted launcher and BM/C^3I brass board testing;
- Completed TMD-GBR UOES critical design review and began fabrication.

Work planned for FY 1995 includes:

- Complete manufacturing of TMD-GBR Dem/Val radar;
- Begin Flight Test program;
- Begin THAAD system tests with TMD-GBR and launcher;
- Procure targets to support THAAD and TMD-GBR flight tests;
- Complete AEGIS/THAAD compatibility study.

Work planned for FY 1996 includes:

- Complete Dem/Val missile and system flight test program;
- Conduct TMD-GBR radar system tests;
- Complete fabrication of UOES radars;
- Exercise UOES missile contract option.

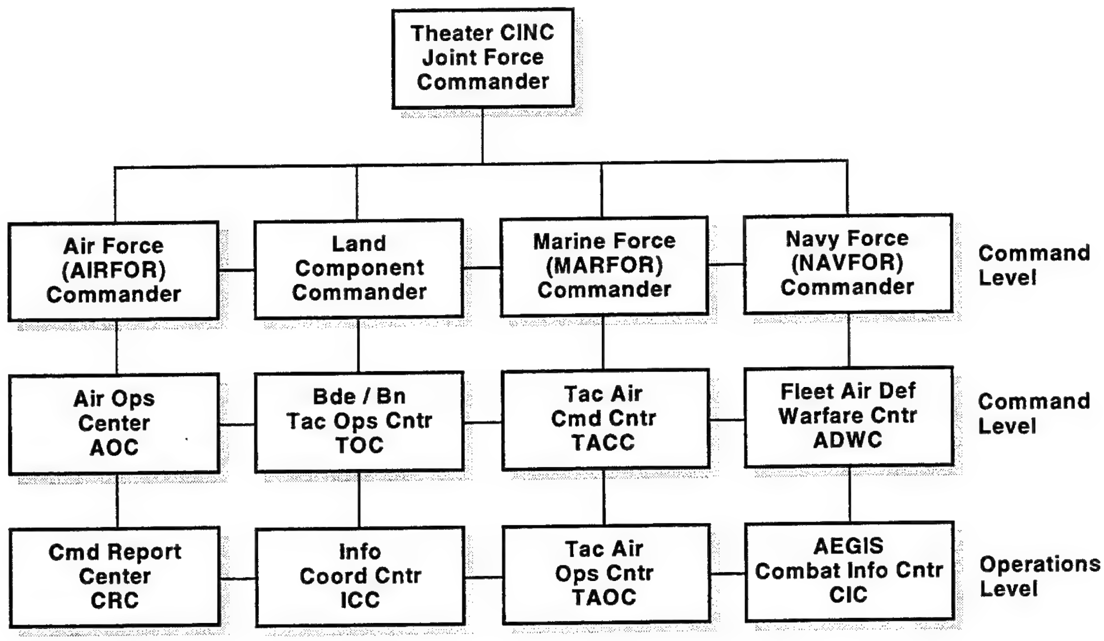
2.9.4 Battle Management/Command, Control, Communications, and Intelligence (BM/C^3I)

Interoperability in Battle Management/Command, Control, Communications, and Intelligence (BM/C^3I) is essential for joint TMD operations. Accordingly, Ballistic Missile Defense Organization (BMDO) continues to take an aggressive lead to establish an architecture that all the Services can build upon and is actively pursuing three thrusts to ensure an effective and joint BM/C^3I for TMD active defense.

2.9.4.1 C^3I Architecture

The C^3I architecture for TMD active defense consists of the Command and Control (C^2) structure for theater air defense; the communications linking TMD C^2, weapons, and sensors; and the TMD interfaces to intelligence systems and other supporting capabilities. Figure 2-12 shows the TMD active defense C^2 organization consistent with current doctrine. The rapid time frames associated with the execution of TMD require closely coordinated command and control for centralized planning and guidance with decentralized execution. To ensure optimized planning and guidance, BMDO is focusing on accomplishing the horizontal linkages among the theater level command

Figure 2-12. TMD Active Defense Command And Control Organization



centers and operations centers that could be deployed in various combinations over time from one theater or contingency to another.

Communications for TMD are designed to make target and engagement information available in near real time to TMD elements at all levels. The functioning of the joint data net is shown in Figure 2-13.

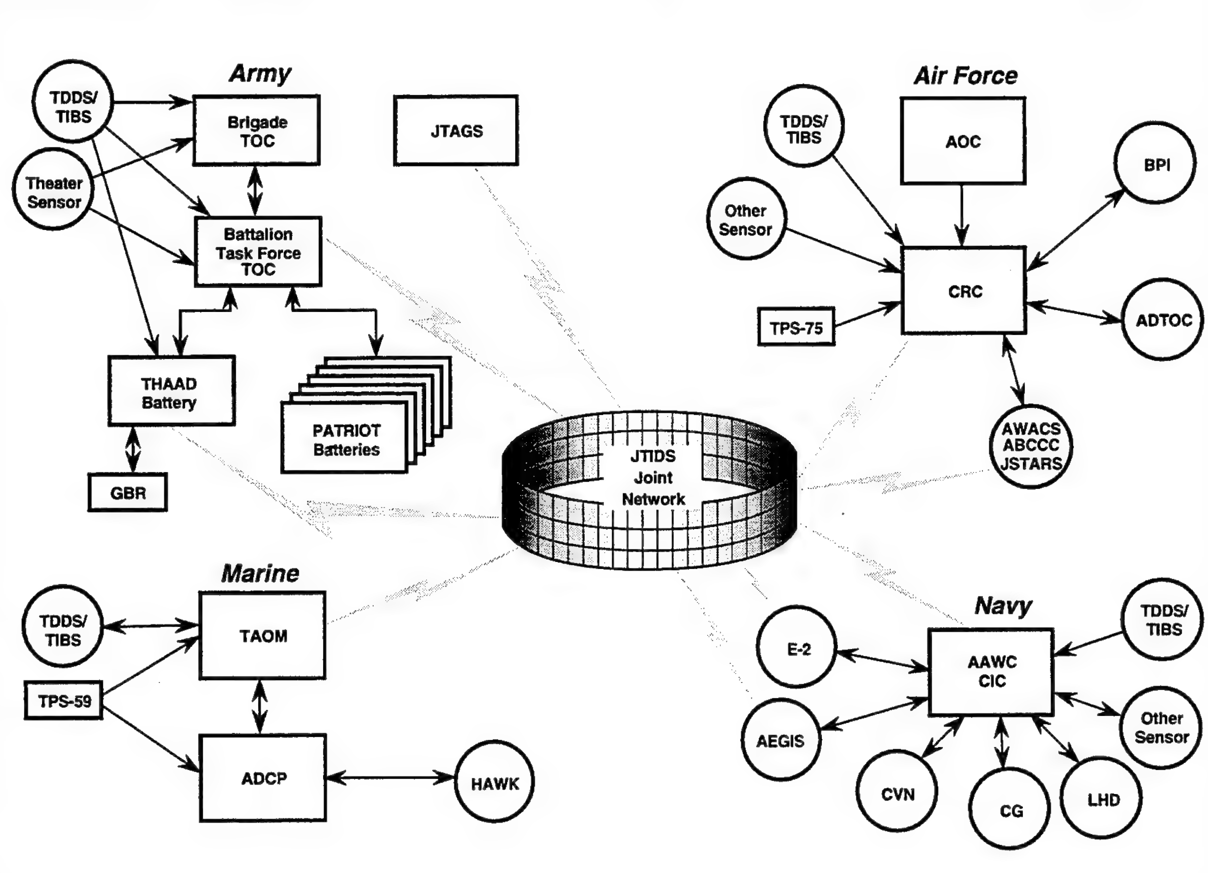
All Services will interoperate via this net, which will allow early cueing of sensors and greater opportunity for TBM engagements. This joint data distribution will contribute to more successful engagements and less leakage of hostile missiles through our defenses.

The intelligence portion of the architecture focuses on Tactical Information Broadcast Service (TIBS) and TRAP Data Dissemination System (TDDS). TIBS and TDDS are satellite broadcast systems which disseminate information from theater and national intelligence resources. TMD forces rely on TIBS and TDDS, in combination with the Joint Near Real-Time Data Net, for receipt of launch warning information produced by tactical processors of DSP data (e.g., Joint Tactical Ground Station (JTAGS) in the theater or Attack and Launch Early Reporting To Theater (ALERT) in Continental United States (CONUS)).

2.9.4.2 BM/C^{3}I Program

BMDO has three major thrusts to the TMD active defense BM/C^{3}I program. The first thrust establishes the links and means for in theater dissemination of launch warning information from

Figure 2-13. TMD Active Defense BM/C^3I Communications Network



space based and intelligence systems external to TMD. As discussed in previous sections, improved capabilities for surveillance and launch warning in support of TMD have already been established through the exploitation of space based systems and development of tactical processing prototypes by BMDO and the Services. Success in this area was the initial thrust of the BM/C^3I program, providing early and responsive support to user commands from JTAGS and ALERT. Additionally, development of a communications gateway, called the Joint Tactical Information Distribution System (JTIDS) / National Technical Means Gateway (NTMG), was initiated in FY 1994. This gateway allows ALERT broadcasts of national sensor warning information, from space as well as theater sensors, sent via TIBS/TDDS to enter the JTIDS network. A prototype of this gateway was demonstrated during United States Atlantic Command's (USACOM's) Joint Task Force 95, and it will participate in May 1995 in Operational Concept Demonstration III/Roving Sands. BMDO continues its role in integrating the TIBS and TDDS with in theater communications and operational systems.

The second thrust of the TMD active defense BM/C^3I program focuses on the communication of information via the Joint Data Net. In conjunction with the Joint Interoperability Engineering Organization (JIEO), BMDO led a subpanel established under the Joint Multi-TADIL Standards Working Group (JMSWG) to define those joint message formats associated with TMD that must be utilized by all the Services in their TMD role. This activity to define standards and interfaces resulted in agreement on common information needs as well as format for joint TMD messages.

A Tactical Data Information Link-J (TADIL-J) interface change proposal was agreed to by all the Services and presented to the JIEO Configuration Control Board for approval.

TMD message formats, associated reporting responsibility rules, and track correlation schemes are being assessed for their adequacy to support TMD requirements by the Air Force's Modeling, Analysis, and Simulation Center at Hanscom Air Force Base. This assessment is scheduled for completion in FY 1995. This approach allows all acquisition activities under the other core programs to develop the appropriate software to integrate communications hardware with host platforms to ensure these systems can communicate with each other. As part of this planning process, the Air Force's Electronic Systems Center, Hanscom Air Force Base, has developed a JTIDS TADIL-J Implementation Plan which outlines the acquisition strategy and costs for integration of TMD capabilities into selected JTIDS equipped BMC^{3}I platforms, including Air Operations Center, Command and Reporting Center, Joint Strategic Tactical Airborne Range System (STARS), Airborne Warning and Control System (AWACS), Cobra Ball, and Rivet Joint. Actual platform integration will begin in FY 1996. A separate study will be initiated in FY 1995 on how best to relay TMD data to theater areas beyond the line-of-sight limitation of a JTIDS network.

The third thrust of the TMD active defense BM/C^{3}I program directs attention to the Service upgrades of C^2 centers. BMDO's central direction and support of hardware and software developments will produce an integrated C^2 capability for TMD. This thrust includes BMDO funded software integration, prototyping, and evaluation activities which have been conducted in conjunction with field and command post exercises such as Roving Sands, Operational Concept Demonstration, Blue Flag, and CINCs' Assessment Program such as Optic Needle. These exercises and war games raise specific issues in operational practices and procedures; and by providing essential insights for joint TMD concepts of operations, they allow BMDO to develop the C^{3}I needed for fully integrated TMD active defense operations.

BMDO will develop a TMD Information Architecture (IA) based on the methodology prescribed by the Department of Defense (DoD) Core C^2 Model. This effort will define a common information structure upon which all the Services can build. The information architecture will serve as a management tool in ensuring that data flows, processing needs, and display items are commonly defined across Service C^2 programs. An additional benefit from building the information architecture is producing an engineering framework from which TMD can grow in the future, as needed, to help constitute the capability for a National Missile Defense (NMD).

As part of the third thrust, BMDO is emphasizing C^2 center developments in an open architecture with maximum use of Commercial-Off-The-Shelf (COTS) software. C^2 information systems that typify this approach include the Navy's Joint Maritime Command Information System (JMCIS) and the Air Force's Contingency Theater Air Control System (TACS) Automated Planning System (CTAPS).

In a continuous effort to validate the C^{3}I architecture and to measure the progress of the three BM/C^{3}I thrusts, BMDO is responsible for testing of integrated BM/C^{3}I for TMD active defense. This includes BMDO sponsored war games which will use the facilities of the National Test Facility (NTF) and the Advanced Research Center (ARC) to refine the information architecture through user interactions and to examine the command and control operational aspects of the fam-

ily of systems. BMDO also uses end-to-end simulations, man-in-the-loop tests, and hardware-in-the-loop tests to validate BM/C^3I requirements and determine that those requirements have been met. To meet the specific needs of TMD testing, systems integration tests will be conducted using the TMD System Exerciser (TMDSE) to simulate the operational environment and to drive each of the elements connected via hardware-in-the-loop. As a distributed test tool, the TMDSE can operate in a wholly simulated environment or in conjunction with live fire test events to demonstrate TMD system responsiveness and performance as an integrated whole. The proof-of-principle demonstration of the TMDSE was completed in FY 1994.

FY 1994 efforts included the following accomplishments:

- Demonstrated C^2 connectivity to national assets;
- Demonstrated JTIDS/NTMG during USACOM's Joint Task Force 95;
- Began prototyping the Air Defense Command Post;
- Executed Operational Concept Demonstration II and C^4I connectivity in Roving Sands 94 exercise;
- Conducted TMD war game.

Work planned for FY 1995 includes:

- Employ JTIDS/NTMG in Operational Concept Demonstration III/Roving Sands;
- Complete theater air defense/TMD process models "As Is " and dictionary of Service terms, and develop process models "To Be" for C^4 system upgrades;
- Complete assessment of TMD message format, reporting responsibility rules, and track correlation schemes;
- Integrate prototype capabilities into air defense TOC weapon systems.

Work planned for FY 1996 includes:

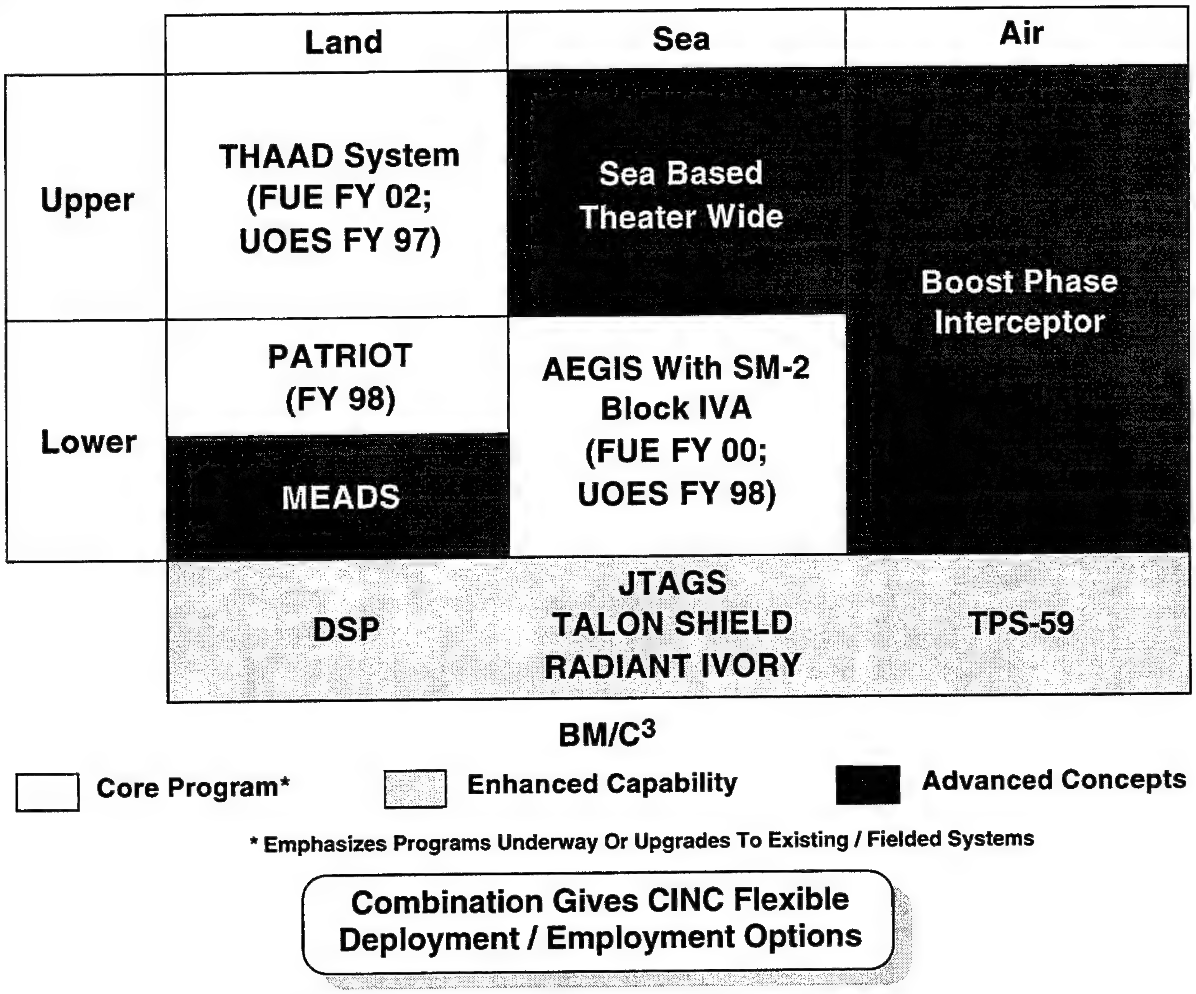
- Complete gateway software development and testing;
- Integrate C^2 connectivity to national assets;
- Demonstrate Lower Tier/Joint interoperability;
- Develop, simulate, and demonstrate prototypes of the recommended CTAPS application for the distributed command and control nodes;
- Conduct NATO TMD war game.

2.10 Advanced Concepts

Currently, three programs are being considered as advanced concepts to complement the core pro-

grams: Medium Extended Air Defense System (MEADS) (formerly Corps SAM), now a multilateral international cooperative program, Navy Theater-wide Theater Ballistic Missile Defense (TBMD), and Boost Phase Intercept. MEADS will provide an easily deployable defense for highly mobile land forces. Navy theater-wide TBMD will provide a worldwide capability to defeat medium-range Theater Ballistic Missile (TBM) threats without the need for forward basing. Boost phase intercept will counter submunitions and reactive threats by engaging TBMs early in their flight paths over enemy territory. Figure 2-14 shows the advanced concepts and the core programs within the Theater Missile Defense (TMD) active defense framework.

Figure 2-14. TMD Active Defense Framework Core Programs And Advanced Concepts



The TMD advanced concepts employ a rigorous new start process which emphasizes reduced cost and advanced technology. Research and development is conducted in areas of interest based on Commander in Chief (CINC) and user input. Technology and manufacturing processes are continuously developed and refined to reduce costs and counter the threat. Advanced technology demonstrations are conducted to provide early assessment of manufacturing capability and acquisition risk in addition to cost and affordability analyses. An advanced concept is considered for a new start based on national priorities, maturity, capability, effectiveness, lethality, current and projected threat, operational need, and affordability. If selected for a new start, the advanced concept

enters the Defense Acquisition Board (DAB) process. If not selected, additional research and development may be conducted to further refine the technology and the manufacturing process and to reduce cost.

2.10.1 Medium Extended Air Defense System (MEADS)

MEADS (formerly Corps SAM) will provide low to medium altitude air and theater missile defense to maneuver forces and other critical forward deployed assets. The system will consist of missiles, launchers, sensors, and Battle Management Command, Control, Communications, and Intelligence (BM/C^3I) elements. It will be deployed and operated by both the Army and Marine Corps. The system will provide 360-degree defense against multiple and simultaneous attacks by a wide variety of tactical ballistic missiles and air breathing threats that employ both conventional and unconventional warheads. Specifically, these threats include short-range tactical ballistic missiles, cruise missiles, unmanned aerial vehicles, and both fixed and rotary wing aircraft. It will be configured as lightweight modules to make it easily transportable and highly mobile. Its fully netted/distributed architecture will provide continuous air defense while its flexibility permits rapid and continuous reconfiguration of system components to meet the demands of each mission. The system will be compatible and interoperable with other assets expected to participate in joint/ combined operations.

The Department of Defense (DoD) signed a Statement of Intent with Germany, France, and Italy to cooperate on a joint development and production of a medium air and missile defense system in February 1995. Working groups have been established to coordinate operational and technical requirements and to develop a memorandum of understanding and statement of work for multilateral cooperation for the Project Definition-Validation (PD-V) phase. The proposed acquisition approach is to select two U.S. industrial teams that will then be required to conduct an international teaming and PD-V effort with European industry. During the PD-V phase, the contractors will be required to define and develop a total system concept based upon the technical requirements document, to conduct a requirements analysis flow down, to establish a contractor-defined baseline system concept, to conduct concurrent engineering design trades, to perform simulations and modeling, to provide life cycle cost estimates, and to establish integrated program plans that include a defined risk assessment and risk abatement plan. Demonstration of critical functions associated with integrated system performance and resolution of key technical issues for the proposed system design concept through the use of end-to-end digital simulation will be required. Following a successful system design review, an Request For Proposal (RFP) for design and development will be issued to the two competing international teams that conducted project definition-validation.

FY 1994 efforts included the following accomplishments:

- Finalized RFP for concept development;
- Initiated coordination of cooperative program with Germany and France.

Work planned for FY 1995 includes:

- Finalized Statement of Intent for multilateral cooperative program;

- Coordinate operational/technical requirements among U.S., Germany, France, and Italy;
- Establish international program management structure;
- Negotiate and conclude memoranda of agreement;
- Award contracts for international teaming with PD-V options.

Work planned for FY 1996 includes:

- Complete international teaming;
- Exercise option to initiate PD-V contract efforts;

2.10.2 Navy Theater-wide TBMD

The Navy Theater-wide TBMD program will provide an upper tier, sea based capability to counter the TBM threat. This program will build on existing AEGIS ships infrastructure and the Navy's core TMD program to develop an interceptor with exoatmospheric capability such as a marinized Theater High Altitde Area Defense (THAAD) or the Lightweight Exoatmospheric Projectile (LEAP). The current effort includes LEAP flight tests, an independent cost and operational effectiveness analysis, and force integration studies including concept engineering.

FY 1994 efforts included the following accomplishments:

- Completed the assembly and testing of two flight kill vehicles to support interceptor tests and provided safety and functional inert test articles to support the safety approval process and missile checkout;
- Conducted final qualification tests for kick stage propulsion;
- Conducted a hover test of a Navy safe solid divert and attitude control system integrated with a kill vehicle;
- Conducted a successful target demonstration flight test.

Work planned for FY 1995 includes:

- Complete AEGIS/THAAD integration studies;
- Complete flight demonstration, analysis, and close-out of LEAP flight test program;
- Complete Navy Theater-wide TBMD Cost and Operational Effectiveness Analysis (COEA), Phase I.

Work planned for FY 1996 includes:

- Complete Navy Theater-wide TBMD COEA, Phase II;

- Conduct command and control studies and demonstrations.

2.10.3 Boost Phase Intercept

The primary objective of the Kinetic Energy (KE) Boost Phase Interceptor (BPI) demonstration program is to demonstrate in FY 1999 the technology for air launched theater missile defense capability to intercept theater ballistic missiles in their boost phase of flight. The most advantageous time to intercept a TBM is during the boost phase of its trajectory while it is still accelerating through the atmosphere. Intercepting a TBM early in its trajectory destroys the missile prior to release of submunitions, thus minimizing the debris fallout on friendly territory and increasing the deterrence of an enemy launch of chemical/ biological/nuclear weapons of mass destruction.

The KE BPI demonstration will assess the operational concept by performing a TBM intercept in a demonstration having an operationally useful scale size and traceability to the Air Force operational requirements document. The KE BPI missile will be an endoatmospheric, and probably exoatmospheric, high-speed advanced tactical missile. The candidate launch aircraft are the F-15 (Air Force) and F-14 (Navy). The program will be managed by Ballistic Missile Defense Organization (BMDO) with Air Force, Navy, and Army participation.

The present program strategy for KE BPI is to continue Kinetic Kill Vehicle (KKV) work through the Atmospheric Interceptor Technology (AIT) program. The Air Force and Navy will refine their Concept of Operations (CONOPS) and address operational issues.

FY 1994 efforts included the following accomplishments:

- KE BPI Advanced Concept Technology Demonstration (ACTD) approved by the Deputy Secretary of Defense;
- Initiated development of a joint concept of operations;
- Conducted hyperthermal tests of cooled windows for KKV.

Work planned for FY 1995 includes:

- Continue development and testing of the KKVs under the AIT program;
- Refine joint Air Force and Navy CONOPS;
- Conduct test planning.

Work planned for FY 1996 includes:

- Continue AIT KKV development;
- Continue missile integration design.

In addition to KE BPI the Air Forces's Airborne Laser (ABL) Demonstrator is a rapidly deployable airborne platform with a long-range high energy laser capable of autonomously detecting, acquiring, identifying, tracking, and destroying theater ballistic missiles in the boost phase. The demonstrator is fully scaleable to the full-scale operational system.

The ABL Demonstrator will be capable of 20-40 missile engagements with an 18 hour on-station time with aerial refueling. The Air Force plans a flight demonstration of a limited operational capability in FY 2002.

2.11 Studies and Analyses

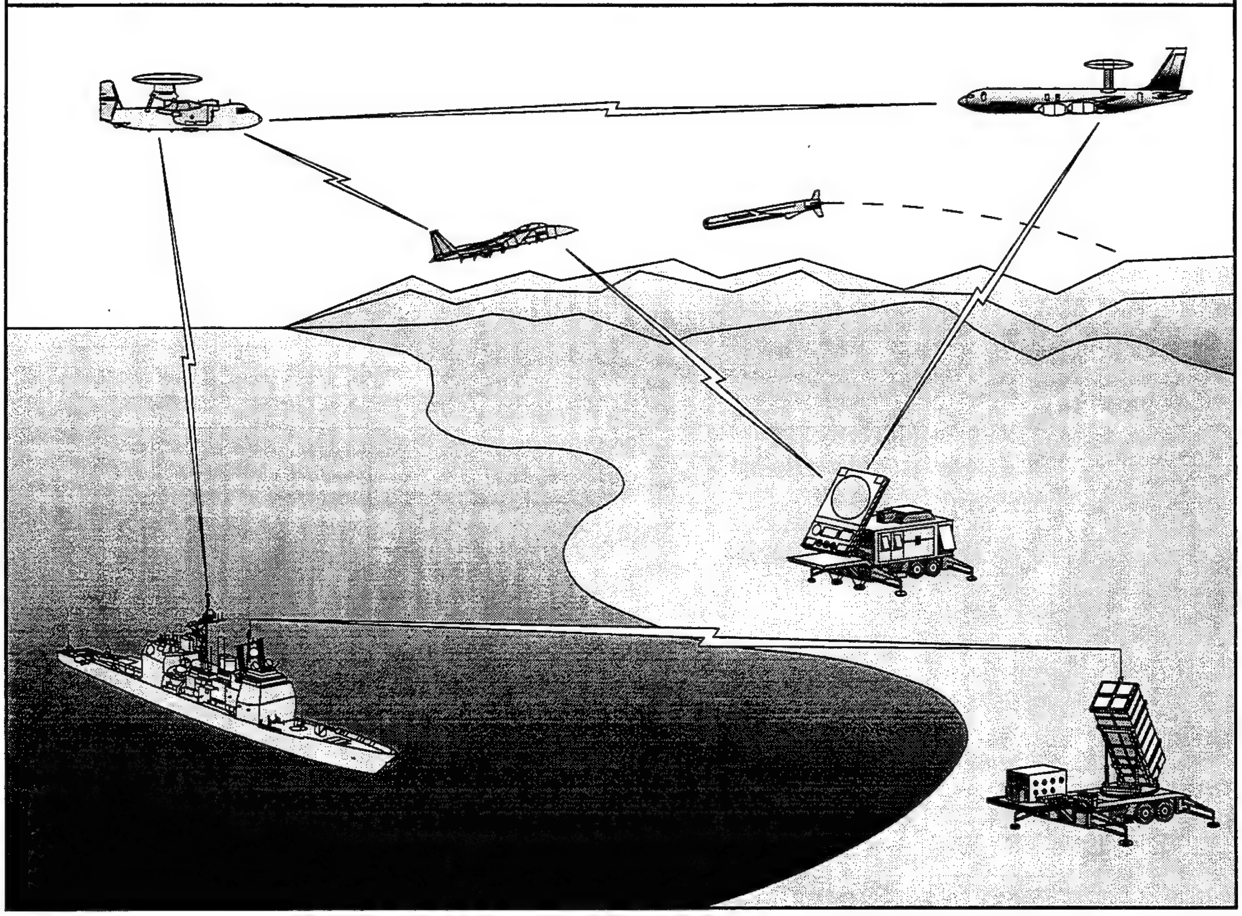
2.11.1 Theater Defense Netting Study

The Theater Defense Netting Study (TDNS) was conducted to evaluate the effectiveness of potential improvements in theater ballistic missile, cruise missile, and air defense through the introduction of netting systems and, where necessary, modifications or additions of sensor or weapons systems. The study examined two time periods (1997-2001 and post 2001) using coordinated threat scenarios, Blue force lay downs, and concepts of operation established by the Army, Navy, and Air Force. Some of the study ground rules are:

- Time Periods:
  - 1997-2001
  - Post 2001
- Geographic Areas:
  - Korea
  - Middle East
- Scenarios:
  - Chosen to show performance of different levels of sensor netting
  - Attacks on military targets, population centers
  - Combined and coordinated ballistic and cruise missile attacks
  - Varying raid sizes
  - Defense assets
  - Currently planned and budgeted
  - Additional sensor, weapon, and communication assets

The study was structured to make maximum use of both completed and ongoing air defense studies and theater air defense studies. Participation was drawn from across the Services and the technical community. Recommendations for netting implementations along with estimates of performance improvements and cost were provided to Ballistic Missile Defense Organization (BMDO) and the theater air defense community. Figure 2-15 illustrates the sensor netting concepts that were studied.

Figure 2-15. Theater Defense Netting Study Sensor Netting Concepts



The TDNS focused on cases where netting defense assets is likely to improve overall defense effectiveness. Cases that were considered included:

- Combined ballistic missile—cruise missile—aircraft attacks;
- Attacks on population centers (low leakage required);
- Attacks during defense buildup (few defense assets);
- Attacks against high value targets (dense threat);
- Low altitude overland cruise missiles;
- Opportunities to reduce fratricide (under joint operations).

The measures of effectiveness that were applied to judge the improvement in performance capability and mission execution included:

- Efficient use of assets (sensors and interceptions);
- Increased defended area;
- Decreased response time;

- Reduced leakage (by threat type and target);
- Reduced fratricide;
- Reduced strategic lift requirements;
- Reduced manpower;
- Reduced costs.

The major conclusions from the study were:

- Netting effectiveness is scenario dependent, but it generally improves the defense effectiveness;
- Netting benefit is a function of sensor overlap, with a higher payoff for cruise missile defense — especially for supersonic cruise missiles;
- Combat Identification (ID) is improved by maintaining track continuity and passing identification derived from wideband radar;
- Satellite range extension of Joint Tactical Information Distribution System (JTIDS) offers operational and cost advantages over traditional relays;
- Airborne surveillance and fire control platform restores coverage lost to low altitude, small radar cross-section cruise missiles.

2.11.2 Comprehensive TMD Missions and Programs Analysis

In August 1994, the Department of Defense (DoD) initiated a comprehensive Theater Missile Defense (TMD) missions and programs analysis. Further, the Program Decision Memorandum directed that four activities comprise the analysis. These activities are: a joint TMD Cost and Operational Effectiveness Analysis (COEA), a technical and engineering analysis of potential program commonalities, development of a TMD command and control plan, and an analysis of TMD threat and mission priorities. BMDO has the lead for the first three activities, and the Joint Staff has the lead for the TMD threat and mission priorities analysis.

2.11.2.1 TMD Cost and Operational Effectiveness Analysis

The purpose of the TMD COEA is to determine the most cost-effective mix of system capabilities and inventories for Theater Ballistic Missile Defense (TBMD) and cruise missile active defense. Office, Secretary of Defense (OSD) has directed BMDO to consider alternative TMD architectures, to include an architecture consisting of the TMD elements that were defined as core programs by the DoD Bottom-Up Review in 1993 (i.e., PATRIOT Advanced Capability Level-3 (PAC-3), Theater High Altitude Area Defense (THAAD) with Theater Missile Defense-Ground Based Radar (TMD-GBR), and Navy Area TBMD). Other architectures being considered include the addition of candidate advanced capability systems (i.e., Medium Extended Air Defense System (MEADS) (formerly Corps SAM), Boost Phase Intercept, and Navy Theater-wide Defense) singly and in combinations. In these various combinations, the cost-effectiveness of alternative missile inventory mixes will be analyzed.

The COEA is a joint study effort, with full participation of the Services and with extensive coordination among them. Each of the study panels (e.g., Analysis Panel, Systems and Cost Panel) has multi-Service membership. The work of each panel draws to the fullest extent possible on analyses accomplished by the Services for all purposes, including COEAs previously conducted for TMD elements. Core program COEAs will be integrated into the Capstone COEA. A Joint Oversight Board (JOB) reviews study progress and products, and helps resolve study issues. At more senior OSD levels, an advisory group and a review group provide guidance for study direction, through the JOB, and resolve any conflicting positions among study participants. The Study Director is tailoring the analysis so that interim products can be available in time for OSD's most immediate TMD acquisition review, i.e., for a Navy Area TBMD System, scheduled for December 1995.

2.11.2.2 Technical and Engineering Commonalities Analysis

The Ballistic Missile Defense Organization is leading a technical and engineering analysis of potential program commonalities and joint efforts. The purpose of this analysis is to evaluate the potential of reducing the life cycle cost of TMD weapon system programs by sharing development and procurement of common technologies and components where feasible. The programs to be included in the analysis are the core programs (PATRIOT, THAAD, and Navy Area TBMD) and the advanced concepts (MEADS (formerly Corps SAM), Navy Theater-wide TBMD, and Boost Phase Intercept). The technology efforts of the TMD core programs and the related BMDO technology programs will be evaluated. The analysis will evaluate potential commonalities down to the major component level such as focal plane arrays and gel divert/attitude control systems.

The commonalities analysis will characterize the functional and design characteristics of individual systems, subsystems and major components based on current system concepts or Demonstration and Validation (Dem/Val) designs. For elements that are applying common or compatible components, the analysis will report existing commonalities. For elements that are applying different technologies or designs for common functions against common threats in common environments, the analysis will review alternative approaches. If the analysis indicates a positive opportunity to apply a common or compatible engineering solution to multiple elements, the potential cost saving that could be realized will be reported including recommendations for implementing the change. The analysis will be completed in 1995.

2.11.2.3 Command and Control Plan

The Ballistic Missile Defense Organization is working with the theater air defense Battle Management/Command, Control, Communications and Intelligence (BM/C^3I) Executive Agent to develop a TMD command and control plan. This plan will include an operational concept; integration and detail use of TMD BM/C^3I within the existing joint air defense architecture; planned modifications for using cues from other sources and providing trajectory data to other users; and exercises required to demonstrate interoperability. The following areas will be addressed:

- The operational concept will definitize how the battlespace will be defended with the various TMD assets, how the defensive mission will transition from sea based assets to land based assets, and how the counteroffensive operations will use early warning information;
- The plan will describe how the BM/C^3I capability supporting the TMD operational

concept will be integrated with the theater air defense joint BM/C^3I architecture to ensure that both functions are supported in the most efficient manner, with minimal increases in manpower and equipment;

- The plan will identify the modifications required for operational and developing systems to accept cues from other sources and to provide trajectory data for other users;
- The plan will discuss how interpretability will be tested in accordance with the TMD Capstone Test and Evaluation Master Plan.

The TMD command and control plan is scheduled for completion by August 1995. The plan will serve as a source document for the TMD Capstone COEA.

2.11.2.4 Analysis of Threat and Mission Priorities

The Joint Staff will conduct an analysis of the threat and mission priorities. This analysis will consider both theater ballistic missiles defense and cruise missile defense. It will be integrated into the TMD Capstone COEA.

Chapter 3

National Missile Defense

Chapter 3
National Missile Defense

3.1 Introduction

The Department's Bottom-Up Review (BUR) concluded that an immediate ballistic missile attack on the U.S. using existing sophisticated ballistic missiles is unlikely, but that a significant probability of attack could emerge in the future as Third World countries develop or acquire simple or perhaps even sophisticated ballistic missiles. BUR guidance and resource allocation has resulted in an National Missile Defense (NMD) program that progresses at a pace considerably slower than that of a full-fledged acquisition program at a funding level of approximately $400M per year (not including the Space and Missile Tracking System (SMTS)). The NMD Program has been structured so that it matures the system components required for as fully effective a defensive capability as an Antiballistic Missile (ABM) Treaty compliant, one-site deployment will allow (the "Objective System"). If the need arises to deploy sooner than the completion of the objective system development, contingency deployment options have been identified based on an estimate of when significant performance improvements might be realized as each of the major pieces of the NMD system (Interceptor, Radar, Precommit Sensor, Battle Management/Command, Control, Communications (BM/C^3)) reach major performance improvement plateaus. At the same time, deployment planning efforts aimed at reducing the time to deploy both the contingency and objective systems are being conducted. The combination of these features is called the Ballistic Missile Defense Organization (BMDO) NMD "Technology Readiness" program.

3.1.1 System Concept

In order to perform the essential ballistic missile defense functions, several basic elements must be integrated as a system: (1) sensor elements to acquire, track, and discriminate the Reentry Vehicle (RV) from nonthreatening objects, provide cueing information to the interceptor, and provide data to verify destruction of the RV; (2) an interceptor element capable of receiving and processing in-flight target updates, performing on board target selection, and providing reliable target destruction; and, (3) a BM/C^3 element for system integration, informed decision making by humans-in-control, and engagement planning and execution, as shown in Figure 3-1.

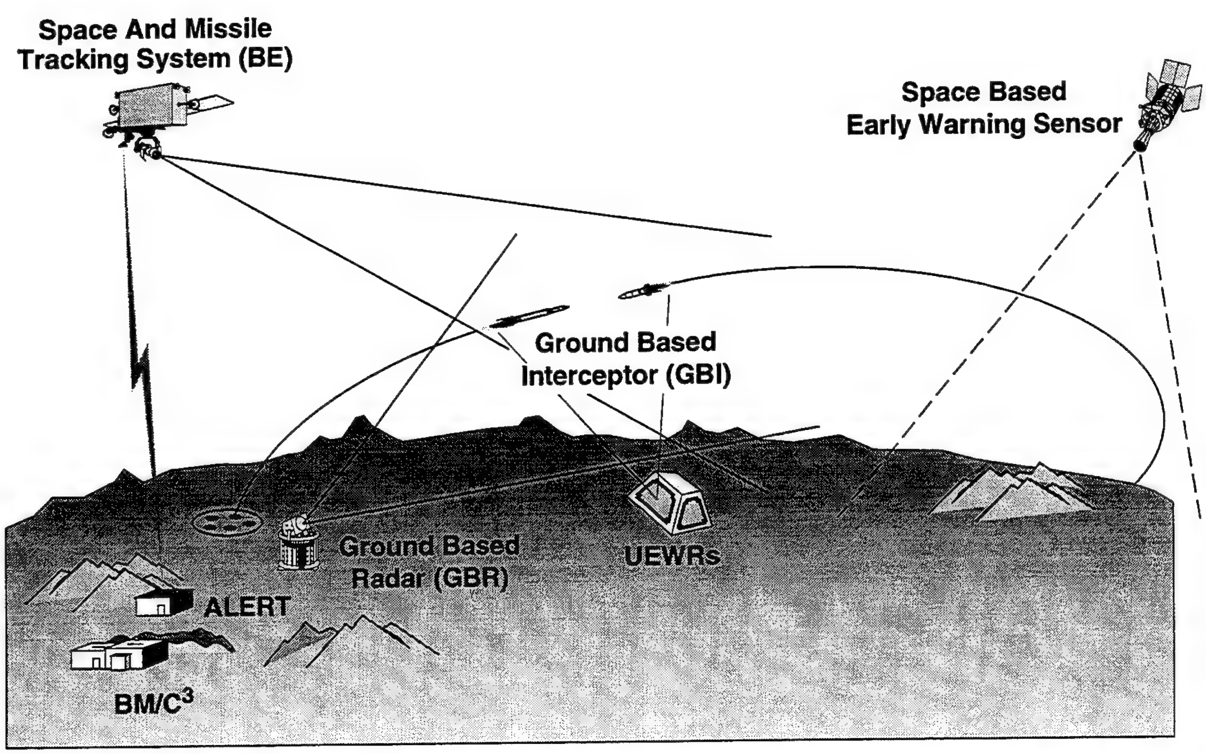
3.2. Threat Driven NMD Program

Threats which have posed or can potentially pose a danger to the U.S. are shown in Figure 3-2.

3.2.1 Former Threats

Global Protection Against Limited Strikes (GPALS) and original Strategic Defense Initiative (SDI) threats are of historic interest only. The original SDI threat (circa early-mid 1980s) contained thousands of boosters and tens of thousands of sophisticated warheads and penaids. The chance of encountering this threat today is currently considered highly unlikely. In the late 1980s the threat was characterized as containing tens of boosters and several hundred warheads, and was the basis for the GPALS program. The chance of encountering the GPALS threat today is considered unlikely.

Figure 3-1. NMD Objective Architecture



Our current attention focus is on ST1-ST4 classes of strategic ballistic missile hardware that exist or are under development.

3.2.2 Existing Threat Hardware

ST4 and ST3 are representative of a portion of the existing Former Soviet Union (FSU) threat. ST4 includes up to 20 warheads, and could be delivered, for example, by two SS-18s used in either a limited deliberate or accidental launch scenario. As such, they are of sophisticated designs and could include penaids and jammers. ST3 includes up to four warheads, and could be delivered by four individual boosters, e.g., SS-25s, or some off-loaded configuration or a larger Multiple Independently-Targetable Reentry Vehicle (MIRVed) booster. The intelligence community rates the likelihood of encountering either of these threats as unlikely now but of heightened risk in the future.

3.2.3 Threat Hardware Under Development

ST2 and ST1 are representative of strategic ballistic missile hardware being developed indigenously by China and Rest-of-World (ROW) countries. ST2 includes up to four warheads with little sophistication beyond a rudimentary ascent shroud in order to present a "cold" target in the midcourse phase of the warhead trajectory, and includes no jammers or penaids. It represents a "Chinese-like" threat. ST1 includes up to four rudimentary first generation warheads typical of the type that could be expected from North Korea, Iraq or India. The timing of both these threats has some degree of uncertainty, but the last assessment by the intelligence community was assumed to be at least 8 - 10 years in the future.

Figure 3-2. Threat Scenarios

Threat	Complexity	Number Of Warheads	Likelihood For Use	Scenario Uncertainty
System Threat (ST) 1	Low	4	Possible	Timing Of Indigenous Development
System Threat (ST) 2	Low	4	Possible	Timing Of Indigenous Development
System Threat (ST) 3	High	4	Heightened Risk	Proliferation, Accident, Unauthorized
System Threat (ST) 4	High	20	Heightened Risk	Proliferation, Accident, Unauthorized
GPALS	Very High	200	Unlikely	Accidental Unauthorized
Original SDI	Very High	1,000+	Highly Unlikely	Deliberate Attack

3.2.4 Proliferation of Existing Threat Hardware

In addition to the discussion above concerning (1) existing hardware that can be a sophisticated threat in the hands of countries "unlikely" to use them against the U.S., and (2) countries who have not yet developed the capability to indigenously produce weapons of mass destruction along with the means to deliver them (i.e., 8 - 10 or more years in the future) but may be "more likely" to use them against the U.S. if they had them, there is a third category of potential threat - the "wild card" or "proliferation" scenario. In this scenario, a country "more likely" to use weapons of mass destruction obtains what is essentially ST3 or even ST4 from one of the FSU states. The main feature of this scenario is that the threat could potentially occur at any time resulting in a very serious, sophisticated threat to the U.S.

3.2.5 Threat Changes and Uncertainties

As demonstrated by recent activities in North Korea and other hot spots around the world, a great deal of uncertainty exists in the assessments used above. In addition, political changes in the FSU could dramatically change our "heightened risk" assessment of having to defend against the FSU attacking the U.S. utilizing ST3, ST4, or an even larger sophisticated threat very quickly.

The NMD technology readiness program provides a hedge against threats premised on hardware that currently exists or is known to be under development. This program is based primarily on uncertainty in the timing and the specific scenario in which a threat may emerge. Although exist-

ing hardware could be proliferated to Third World Countries, no assessment is currently available which indicates that this is any more or less likely than a given recipient country developing an indigenous capability. Accordingly, the NMD program has as a goal to provide insurance against both possibilities as rapidly as funding permits.

3.3 Evolving Technology Readiness

A key feature of the NMD technology readiness program is the availability of increased system effectiveness over time as technology is demonstrated. Significant increases in system effectiveness are expected by the end of the following time frames: Early Term, FY 1995-1997; Mid Term, FY 1998-2000; and Objective System, FY 2001-2003. Deployment planning will focus on reduction of lead times and risks and will be updated on an annual basis.

3.3.1 The Objective Capability

The NMD objective system is defined to be that which can address threat classes ST1 through ST4 in terms of meeting operational requirements against such threats.

As shown in figure 3-1, the objective system architecture consists of (1) early warning systems (Space Based Infrared System (SBIRS) Geosynchronous Earth Orbit (GEO) satellites and Upgraded Early Warning Radars (UEWRs) [if available]), (2) a Ground Based Interceptor (GBI), (3) a Ground Based Radar (GBR), (4) a Space and Missile Tracking System (SMTS) precommit sensor, and (5) Battle Management/Command, Control, Communications (BM/C^3). A single NMD site could provide good protection against a small attack of up to four warheads of type ST1 - ST3, and adequate protection against ST4 threats (up to 20 Reentry Vehicles (RVs)) for Continental United States (CONUS) and Alaska. The complete objective system could be demonstrated within a $400M per year NMD budget (not including SMTS) by about 2003. The objective system architecture matures in an evolutionary manner. Early versions of the GBI and the BM/C^3 can be available for contingency deployment starting in 1998.

SBIRS GEO is needed for the launch detection and attack warning. Early warning radars (BMEWS and PAVE PAWS) would supplement the track data acquired by the SMTS space based sensor, although they are not critical since the SMTS satellites would provide accurate threat state vectors.

The GBI consists of a nonnuclear, Hit-To-Kill (HTK) Exoatmospheric Kill Vehicle (EKV) mated to a high-speed booster that can destroy strategic Ballistic Missile Defense (BMD) threats in the late midcourse portion of their flight. The GBI uses precommit and in-flight target update sensor data to lock onto the threat. In the endgame, the EKV seekers are used to select targets from other associated objects and home in on the target. After flight tests of the EKV seeker, an initial EKV intercept of a class ST2 target is planned for FY 1998. Beginning in FY 1998, the EKV will incorporate radiation hardened components for survivability. The EKV and booster subsystems will be flight tested against ST3 - ST4 class targets beginning in FY 2000.

The GBR consists of an X-band single faced phased array radar that can be physically rotated as well as electronically scanned. As a primary sensor for NMD, the radar performs surveillance,

acquisition, track, and support to discrimination, fire control, and kill assessment. To support pre-commit, the radar searches autonomously or in response to a cue, will acquire, track, classify/identify threat objects and estimate object trajectory parameters. The radar will pass to the BM/C^3 engagement planner all objects which it classifies as threat targets and other objects of interest. The BM/C^3 engagement planner will use these data to develop a weapon tasking plan for the interceptor and sensor task plans for the GBR. The radar schedules its resources in response to the sensor task plans to continue to track the target to provide data to support the generation of the In-Flight Target Update (IFTU) and a Target Object Map (TOM) to assess the intercept and destruction of the target. A demonstration radar, Radar Technology Demonstrator (RTD), will be built at the Kwajalein test range beginning in FY 1998 using components of the Theater Missile Defense Demonstration and Validation (Dem/Val) radar and additional NMD software. The RTD will have sufficient performance and be ready to observe ST1 - ST4 class targets beginning in FY 1999.

The Space and Missile Tracking System (SMTS) is a constellation of low earth orbiting satellites containing Infrared (IR) sensors which provide midcourse tracking of RVs. The SMTS is able to acquire and track RVs at longer ranges than Early Warning Radars (EWRs) and GBR, thus increasing the probability of kill and battle space for shot opportunities. The objective SMTS relies on long wavelength IR to discriminate ST3 - ST4 threats from associated objects against a cold space background. Since the SMTS is not susceptible to radar jamming, it provides a robust capability to counter ST1 - ST4 class threats. The SMTS Fight Demonstration System (FDS) will demonstrate the functional and operational performance, and validate the system design approach to support the decision to develop and deploy an objective SMTS. The FDS will be comprised of two satellites to be launched in FY 1998 for a multiyear test program. To aid development, mitigate risk, and predict performance, a pathfinder sensor unit will be built and ready for validation testing in the contractor's facility in FY 1997. This ground demonstration of the flight sensor will be used to predict the flight performance of the sensors on the FDS and develop an on-orbit anomaly resolution data base to support the FDS operations. At present the SMTS is planned to be used as an adjunct to the GBR which will serve as the fire control sensor.

The NMD Battle Management, Command, Control, and Communications (BM/C^3) system comprises three functional components: Commander in Chief (CINC) BM/C^3, Site BM/C^3, and Engagement Planning. CINC BM/C^3 will provide the means for overall CINC command and control (C^2) of NMD assets, Human-in-Control (HIC) direction, and the interfaces with external systems, e.g., Attack and Launch Early Reporting to Theater (ALERT). CINC BM/C^3 also provides extensive decision support systems and displays, and situation awareness by correlating the best available data from the weapons and sensors. Site BM/C^3 will provide local interelement integration for radar and interceptor operations, provide in-flight data links (required for In-Flight Target Update/Target Object Map (IFTU/TOM)). Engagement Planning will generate integrated weapon, sensor, and communications task plans critical to GBI and GBR performance, In-Flight Target Updates, and Target Object Maps. BM/C^3 development includes hardware and software that supports command and control decision making and integrates NMD sensor and weapon elements to make the NMD system compatible with current and planned Command and Control (C^2) structures.

The objective capability will be demonstrated through a series of increasingly sophisticated simulations, ground tests with Hardware-In-The-Loop (HITL), and flight tests. Beginning in FY 1999, intercepts involving the EKV, RTD and BM/C^3 will test the ability of these elements to operate as

a system. Beginning in FY 2000, both ground elements and space based SMTS will participate in demonstrations of the objective capability.

3.3.2 Early Term Capability

Consistent with evolution to the objective capability, an early NMD contingency deployment would consist of (1) existing early warning systems (satellites and radars), upgraded as necessary; (2) a ground based interceptor consisting of an EKV and modified existing boosters, (3) an NMD radar derived from the TMD-GBR, and (4) BM/C^3 derived from BMDO engagement planning and decision support software prototypes developed and demonstrated by the BM/C^3 program. Although there is no space based midcourse sensor capability, good CONUS protection (>85% probability of zero leakers) against a small attack of up to four warheads of type ST1 and ST2, and some protection against ST3 threats is possible. For use in a single-site configuration, this capability could be demonstrated within a $400 million per year NMD budget (not including SMTS) by 1998. In the case of a decision to deploy before 1998, additional funds would allow the development of this capability to be accelerated by about one year along with current deployment activities.

A prototypical GBI could be created by integrating a kill vehicle with existing booster stages modified and stacked to meet the threat intercept performance requirements. Neither the Exoatmospheric Reentry Vehicle Intercept System (ERIS) missile nor the Lightweight Exoatmospheric Projectile (LEAP) has been used with radar and BM/C^3 elements to demonstrate the system capability required to meet ST1 - ST2 threats. Both were designed as experimental vehicles to determine the technical feasibility of kill vehicle technologies. The ERIS program ended in 1992 and the project team has since been disbanded. The LEAP technology integration program vehicles are currently sized for targets acquired at closer range than those needed for use against ST3 and ST4 class threats. Therefore, an interceptor for an early option to deploy has yet to be demonstrated. An exoatmospheric kill vehicle, derived from the ERIS, LEAP, and other technologies that has the enhanced acquisition range and divert velocities needed for reasonable effectiveness against the ST1 and ST2 threats is currently in development. The EKV concept incorporates all the kill vehicle functions necessary to support an early capability against ST1, ST2, and some capability against ST3 and is planned to evolve to an objective capability. Programmatically, the current BMDO EKV project is a lower risk path to achieving the necessary early system capability in about the same amount of time and for about the same cost as alternative kill vehicle concepts considered (such as a kill vehicle with a sensor interstage). A review of alternative kill vehicles shows that integration and testing of these vehicles may be a significant risk. For example, the concept of interstage sensor data being able to provide timely updates for kill vehicle course corrections remains to be demonstrated. Much of the software remains to be developed and tested. The time to do this and other hardware in the loop testing of the kill vehicle and the interstage needs to be determined before an assessment of the risk can be performed.

Existing early warning radars can provide, with some software modifications, track data to support BM/C^3 weapon tasking against simple threats. However, they have limited ability to provide high accuracy track data required for IFTU and TOM development. Furthermore, they are susceptible to simple countermeasures (e.g., Ultra High Frequency (UHF) jammers) which can severely degrade their ability to support BM/C^3 information requirements. Real-time algorithms and processing needed to discriminate strategic threat objects (decoys, debris, etc.) have yet to be developed. In addition, some of these radars are on foreign soil, a fact that might limit United

States options to upgrade or use them. Because of early warning radar shortcomings it is necessary to provide a more robust capability. The addition of a prototypical National Missile Defense-Ground Based Radar (NMD-GBR) derived from ongoing TMD technology can provide this capability against limited threats. This prototypical GBR (known as Radar Technology Demonstrator (RTD)) would also be on the path to improvements beyond the early capability. For example, if deployed in a multisite configuration, which would not be ABM Treaty compliant, but might become necessary under some future circumstances, the NMD-GBR and Upgraded Early Warning Radar (UEWR) combination could provide substantial protection against the ST3 threat.

Finally, the existing BM/C^3 models and prototypes need to be expanded and upgraded to operationally address ST1 and ST2 threats (and some capability against a ST3 threat). Real-time integration of all the elements would be necessary, as would real-time operational support (e.g., decision aids, ability to disseminate and execute human decisions).

The preferred architecture for an Early Term contingency deployment includes EKV-based GBIs, a GBR, UEWRs, and the BM/C^3 necessary for essential interoperability and interface with existing C^{4}I systems as well as interelement communications. The Defense Support System (DSP) satellites support this architecture by serving as the attack warning sensor.

3.3.3 Mid Term Capability

If no deployment decision is made at the end of the Early Term, development activities will continue on the path to the Objective System. Continuing technical progress in the program will lead to increasingly more capable contingency deployment options. Technical progress made with the EKV in the Early time frame will be the basis for an improved EKV in the mid term. Mid term GBI improvements will include developing an optimal booster to improve overall capability, enhancing reliability, availability, and maintainability, and incorporating kill vehicle contractor design iterations resulting from the early seeker fly-by and intercept flight tests. Candidates for technology infusion include hardened focal planes developed under the Pilotline Experimental Technology (PET) and or Silicon Hybrid Extrinsic Long-wavelength Detector (SHIELD) programs as early as FY 1998, and a lightweight 20/44 GHz transceiver developed under the communications engineering program (FY 1999). Kill Vehicle (KV) contractor design iterations are likely to occur in signal processing hardware and in target selection software.

The Medium/Long Wavelength Infrared (M/LWIR) capable SMTS Flight Demonstration Satellite (FDS) vehicles are planned to be flown in FY 1998 to begin a multiyear flight demonstration of over the horizon cueing, and improved tracking and discrimination performance robustness to threat countermeasures based on dual phenomenology sensors - (passive infrared and active radar). The SMTS FDS data and demonstrations, coupled with advances in LWIR focal plane technology and cryocoolers, will allow a mid term deployment of SMTS satellites. The minimum time to deploy a limited number of LWIR equipped SMTS satellites is about five years.

Reconfiguration of the TMD-GBR hardware for NMD-RTD use will be completed in FY 1998 for the start of testing to validate NMD unique algorithms for target acquisition, tracking and discrimination performance. The FY 1999 EKV flight test will be used as a verification and measurement test for the NMD-RTD. This test will verify radar performance, demonstrate successful resolution of the critical issues, and verify the radar data hand over to BM/C^3. In addition, the NMD-RTD

will collect data to update the NMD simulation models. This test will be followed by a series of integrated system flight tests where the NMD-RTD will perform its fire control mission for the NMD system.

Annual EKV Integrated Flight Tests (IFTs), which begin with seeker flight tests in FY 1997, are the key to establishing system level performance that validates the increasing capability available for contingency deployment. These IFTs will integrate the other elements as their capabilities mature to demonstrate integrated NMD operation. BM/C^3 and the RTD will be integrated at Kwajalein for calibration and check out during flight tests in FY 1999 and fully integrated and activated in FY 2000. Additional BM/C^3 improvements augment the C^2 decision support capabilities and modify integrated engagement planning for UEWR/SMTS/GBR/EKV operations to include providing IFTUs and TOMs to the EKV by FY 2000. The integrated flight tests will continue at the rate of about one per year in order to validate the successful resolution of key issues within the NMD program. These issues include integration of the weapons, sensors, and BM/C^3, demonstration of the weapon/sensor hand over, demonstration of tracking and discrimination algorithms, and demonstration of reliable hit-to-kill intercepts. The successful accomplishment of the test objectives in the integrated flight tests will provide the confidence that the evolution to increased capability contingency deployment options has been achieved.

In summary, NMD capability will be demonstrated through yearly integrated system flight testing and will result in a mid term contingency option that provides robust single site protection of the continental U.S. against threat categories ST1 and ST2 and good protection against ST3.

3.3.4 NMD Program Schedule

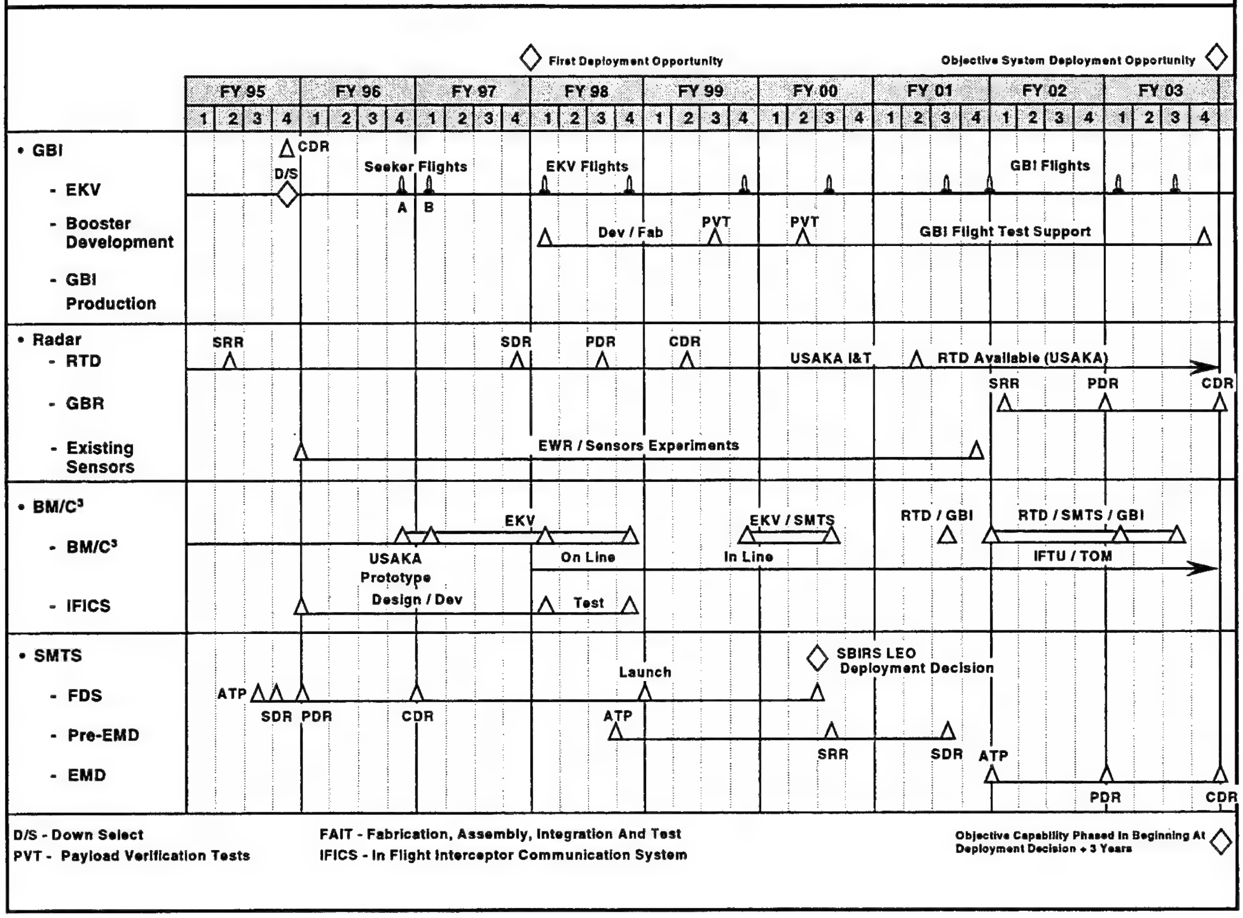
The current BMDO Technology Readiness Program is structured to support development and testing of critical elements of the NMD architecture evolution. Figure 3-3 displays the overall development and test schedule for the NMD Technology Readiness Program. This schedule, and the narrative throughout this report reflects the program as depicted in the FY 1996 President's Budget.

3.4 NMD System Engineering and Integration Process

The BMD Capstone Operational Requirements Document (ORD), dated December 1994, defines the system level operational requirements. The NMD System Requirements Document (SRD) allocates the system requirements to the elements by balancing and optimizing element requirements within the architecture. The SRD contains the requirements for a contingency deployment in each development time frame and will serve as the capstone system requirements and element allocations document for an operational contingency NMD system. NMD system performance will improve with each development time frame because of the planned advances in technology.

The system engineering efforts will result in the definition of system/element test requirements for NMD testing scheduled to begin in FY 1997, with the Ground Based Interceptor/Exoatmospheric Kill Vehicle (GBI/EKV) seeker flight tests. As element and system tests are conducted, results will be evaluated against test predictions, system and element requirements, and, where necessary, used to adjust element designs to rebalance the NMD system.

Figure 3-3. NMD Baseline Program Schedule



Refinement of top-down system level derived requirements based on demonstrated tests will validate system element integration and ensure interoperability and compatibility between NMD elements.

3.5 System Capability Demonstration

A key feature of the NMD development program is the demonstration of the prototype system capability. Realistic Integrated Flight Tests (IFTs) against threat representative targets are the key to demonstrating an effective prototype ballistic missile defense for the United States. While early tests will employ simulation as well as Hardware- and Software-In-The-Loop (HWIL/SWIL) for elements not yet available, later tests will demonstrate the integrated capabilities of the entire NMD system in realistic flight tests. Whenever possible, NMD system integrated tests will leverage off of the EKV flight test program. Other NMD elements will be integrated into these tests as their development progresses. Since cost constraints preclude more frequent flight tests, modeling and simulation and Integrated Ground Tests (IGTs) will be used to prepare for, and augment, the integrated flight tests throughout the NMD system test program. The Integrated Systems Test Capability (ISTC) is a HWIL/SWIL test support tool that will be developed as the centerpiece to conduct IGTs for the NMD system.

The integrated flight tests will demonstrate the functional capability of an NMD system. These functions include integration of the weapons, sensors, and BM/C^3. The result of these efforts will be an NMD capability that could be the basis to acquire and deploy a robust, ABM Treaty compliant, single site protection of the continental U.S. against quantitatively limited threats.

3.6 Deployment Planning

Reduction of the time to deploy is a major objective of the NMD Technology Readiness Program. In order to plan activities that can accomplish this, a joint BMDO and Service Contingency Deployment Plan (CDP) is under development. It will show cost, schedule, performance and risk, of deploying a contingency NMD system at any time. Although the first priority is to plan for an ABM Treaty compliant system, the plan will also include ABM Treaty noncompliant options. The CDP will aid in prioritizing funding and activities that can lead to reducing the lead time to deploy a system, consistent with Congressional direction, that limits the acquisition of hardware before a decision to deploy is made. Crucial to successful deployment planning is the identification and analysis of all system operating requirements and individual element development and deployment functional activities. Also crucial is identifying deployment "long poles" that must be addressed and worked at the system and element level. The output from the planning effort will be a complete, sequential picture of all the activities needed to deploy a contingency system.

3.6.1 Reducing the Lead Time to Deploy

A July 1994 quick-look assessment revealed that planning must focus on all activities required to design, fabricate, and deploy a contingency system. As planning evolves, many of the activities identified will be integrated into the NMD development projects where possible.

The preliminary assessment identified two potential long poles for early deployment:

- Site development and integration of the elements, on site, with the accompanying environmental compliance; and
- Kill vehicle development and fabrication.

Additionally, these initial assessments identified several ways to address the "long poles." Some of the specific opportunities to accelerate deployment include:

- Developing and negotiating specific acquisition, contractual, and potential environmental waivers to be put in place prior to a deployment decision;
- Performing specific actions needed to mitigate regulatory compliance delays. For example, an Environmental Impact Statement (EIS) for single site deployment can be developed ahead of time. This EIS would be broad enough to provide environmental coverage as the NMD capability evolves in the future;
- Conducting critical path analyses for each element;
- Identifying items and materials already in the supply system that can be used during

deployment;

- Completing facility stabilization activities at the initial site;
- Updating the Stanley R. Michelsen Safeguard Complex site survey;
- Performing the 35% design of critical facilities; and
- Developing a production and manufacturing strategy which will be coupled with an industrial capabilities data base.

Overall, thorough critical path analysis of the Technology Readiness Program is essential to identifying the activities to be funded for contingency deployment in order to develop and maintain the capability to deploy in three or less years once such a decision is reached.

3.6.2 Contingency Deployment Planning

As part of the ongoing NMD program planning, some preliminary estimates of deployment times have been made. If a 1997 deployment decision is made, we estimate that the ground based system can be deployed in about 24 to 42 months, and the full objective system, consisting of ground based and space based elements, could be deployed in about seven years. This estimate is based on completion of EKV capability development and progress in developing the SMTS capability.

Since the exact date a threat may emerge cannot be predicted with certainty, a deployment decision may be required prior to 1997 when completion of the early capability is planned. If that should occur, a concurrent development and deployment program would be implemented. This program would be structured to deploy at a single site in about four years.

If a deployment decision is made in 2000, the GBI, GBR and BM/C^3 ground based elements could be deployed in about three years. The full objective system with the initial SMTS, equipped with Long Wavelength Infrared (LWIR) sensors, could be deployed in about 5 years. If a decision to deploy is made in 2003, the full objective system could be deployed in about five years.

3.7 TMD Program Leveraging

The NMD Technology Readiness Program will capitalize on those technologies matured through development and fielding of BMDO's Theater Missile Defense (TMD) systems. For example, the development of ground based radar for TMD, which has a high degree of commonality with the radar planned for NMD, will reduce costs and lead times for the National Missile Defense-Ground Based Radar (NMD-GBR). The Radar Technology Demonstrator (RTD) program will leverage off the Theater Missile Defense-Ground Based Radar (TMD-GBR) program in both the software and hardware areas. NMD-GBR unique critical issues of discrimination, target object mapping, mechanical and electronic scan, and kill assessment will be resolved separately and integrated into the RTD.

The resulting RTD design will use existing TMD hardware by incorporating the 12,500 TMD-GBR Demonstration and Validation (Dem/Val) Solid-state Transmit/Receive modules into the RTD antenna. Additionally, the RTD will reconfigure and use the existing TMD-GBR's Cooling Equipment Unit (CEU), Operator Control Unit (OCU), and Electronic Equipment Unit (EEU).

Although the NMD and TMD missions are significantly different, the EKV program will leverage off the TMD technology developments to the maximum extent practical. Stressing challenges that are similar in both NMD and TMD include issues such as on board sensor fusion, BM/C^3 interfaces, logistical support, wafer scale integration electronics, and producibility of certain sub-components such as Inertial Measurement Units (IMUs).

3.8 Potential to Evolve to Higher System Effectiveness

While the NMD Objective capability can be used to develop a system that provides good protection for most of the U.S. against the full spectrum of assumed potential threats, there is a very real possibility that the sophistication of potential threats will continue to evolve. To accommodate changes, further technology improvement of existing components can be pursued, as can multi-site operations or the addition of a space based element to the defensive architecture.

Greater capability against more stressing threats than ST4 can be achieved, for example, by increasing the discrimination performance of the GBI, the GBR and SMTS and burnout velocity of the GBI. Greater performance from a single site is also possible by adding more interceptors. The most highly effective defenses of the entire U.S., including Alaska and Hawaii, are provided by interceptors at multisite locations.

The addition of a space based weapons element to the NMD architecture has significant payoff in defending the U.S. against an attack from any location on earth. Continuous global coverage provided by a space defense allows a highly increased probability of zero leakers not only for Continential United States (CONUS), but for Alaska, Hawaii, and all U.S. territories as well. Such a system operating in the boost phase of an Intercontinental Ballistic Missiles (ICBM's) flight makes the NMD system relatively immune to countermeasures that might occur over the next decade and beyond.

Chapter 4

Advanced Technology Development Strategy And Programs

Chapter 4
Advanced Technology Development Strategy And Programs

4.1 Technology Investment Strategy

The Ballistic Missile Defense (BMD) investment strategy for sustainable development is to acquire Theater Missile Defense (TMD) systems that meet today's requirements and, at the same time, to anticipate potential future ballistic missile defense requirements and the technology needs of tomorrow. Accordingly, these BMD efforts concentrate on affordable, high payoff technologies, including those available through cooperative programs with our allies, that can:

- Enable and assure the continuing vitality and potential improved performance and affordability of the deployed TMD system;
- Demonstrate the technology base to defend against advanced threats such as maneuvering targets, straightforward countermeasures, advanced submunitions and weapons of mass destruction;
- Offer alternate system approaches (architectural flexibility) that can provide major increases in TMD and National Missile Defense (NMD) capability against an uncertain, evolving threat.

In essence, we are developing the technology that is essential to meeting the BMD mission over the long haul.

In keeping with Congressional direction in the FY 1994 National Defense Authorization Act, several Ballistic Missile Defense Organization (BMDO)-managed technology programs directed towards far term ballistic missile defense have been transferred from BMDO management. Remaining advanced technology efforts focus the BMD program on those concepts necessary to maintain prudent exploratory and advanced development options.

4.2 Technology Needs

To maintain the viability of a BMD architecture over time, technologies being developed must provide options for improvements to deployed defenses or replace those deployments with new capabilities to respond to a range of needs. Among the most important of these needs are capabilities to:

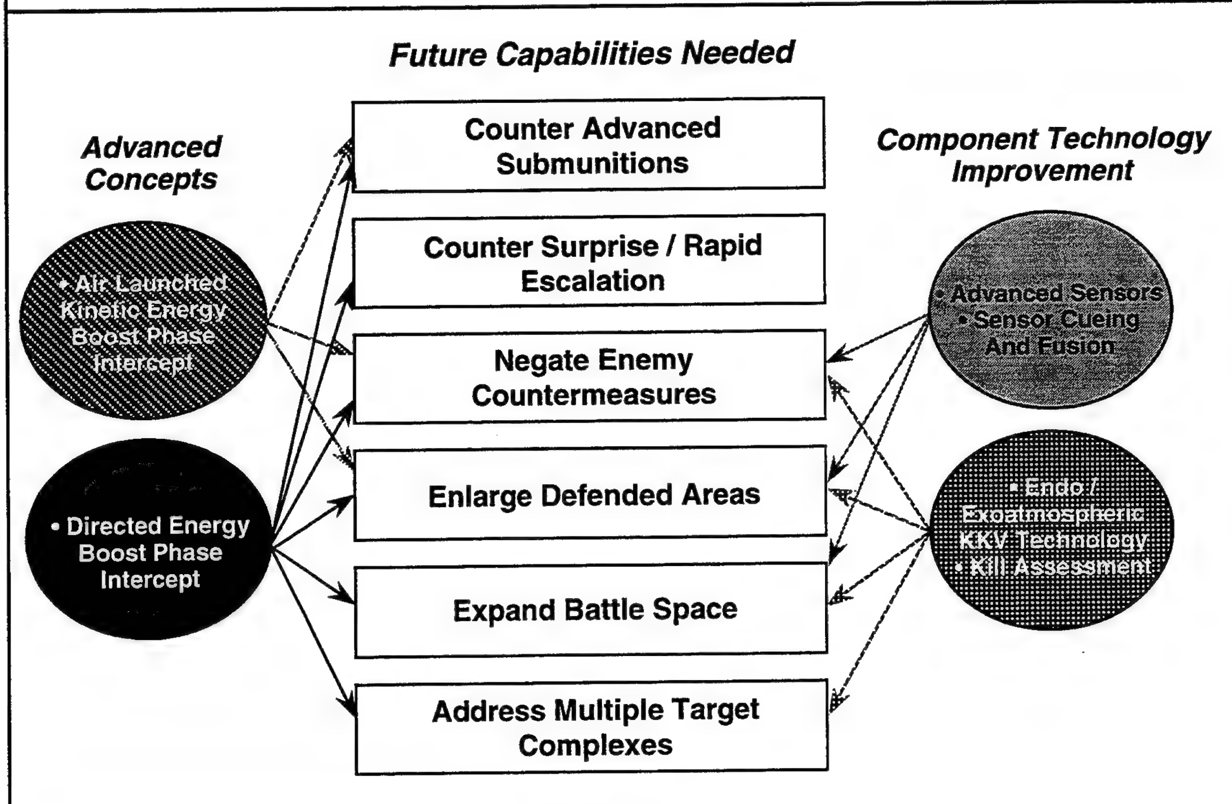
- Meet straightforward countermeasures such as penetration aids or electronic countermeasures;
- Cope with threat evolution such as advanced submunitions that improve the effectiveness of the attacking missile, longer range missiles that enlarge the areas that can be attacked, and maneuvering and less observable targets;
- Handle proliferation of ballistic missiles and an increasing number of countries possessing the technology for weapons of mass destruction. This proliferation demands greatly expanded battle space, increases the potential for surprise, and leads to the need for rapid deployment of TMD to counter rapid escalation of a conflict.

To prepare to meet these future needs, the BMDO is investing in the high leverage technologies that can provide:

- Intercept of theater ballistic missiles in boost phase of flight to reduce the burden on midcourse and terminal tier defenses;
- Continuous coverage to detect a surprise attack or monitor the early states of a rapidly escalating conflict;
- Exoatmospheric and endoatmospheric intercept capability with high probability of kill at reduced technical risk and program cost to expand battle space, increase defended area coverage, and provide quick response solutions to theater defense;
- Multisensor detection and tracking that extends through the missile flight path to provide the earliest possible alert, midcourse tracking; and
- Identification, discrimination, homing guidance, and aim point selection and kill assessment to support early assured targeting and effective battle management.

Figure 4-1 diagrams the future threat in terms of capabilities needed and potential technology solutions. Arrows point from each critical technology solution to the mission needs which that solution addresses.

Figure 4-1. Technology Needs



4.3 Program Overview

The current advanced technology development program is structured in four major segments: Air Launched Kinetic Energy Boost Phase Intercept, Directed Energy Boost Phase Intercept, Advanced Sensor Technology, and Advanced Interceptor and System Technology. Figure 4-2 provides the current schedule for each segment.

Figure 4-2. Advanced Technology Schedule

Technology	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00
Air Launched Kinetic Energy Boost Phase Intercept	▲ KE BPI ACTD Plan Developed	Hi-speed Window Tests △	△ Optical Seeker Tests	△ Kill Vehicle Design Review	△ Hover	△ Tests △ Flight	△ Demos
Directed Energy Boost Phase Intercept (Chemical Laser)	Deliver Inertial Measuring Unit ▲ Apply LAMP Mirror Grating ▲	△ HABE Infrared Track Experiment (Ground) ALI Optical Bench Assembly △	△ ALI Subsystem Integration Test	△ ALI High Power Tests			
Advanced Sensor Technology	▲ MWIR BTH Track Experiment	△ Multi-quantum Well Sensor Demo	△ Two-color Multi-quantum Well Sensor Demo	△ On-focal Plane Processing Demo	△ Individual Passive / Active Sensor Demo	△ Integrated Ground Passive / Active Sensor Demos	△ Integrated Flight Passive / Active Sensor Demos
Advanced Interceptor And System Technology	▲ STRV-1b Experiment Launch	△ ACTEX-1 Launch △ STEP-3 Launch	△ Superconductor LWIR Signal Processor Cooler Demo △ Folded CO_2 LADAR Demo	△ STRV-2 Experiment Launch △ EFEX1 Launch △ Solid-state LADAR Demo	△ Superconductor LWIR, Continuous Cooler Demo △ Advanced Ground Power Demo	△ EFEX2 Launch	△ EFEX3 Launch

4.3.1 Air-Launched Kinetic Energy Boost Phase Intercept (BPI)

The BPI program will integrate and demonstrate critical technology elements into a full-up system that can support airborne BPI concepts for the Air Force and Navy. Early boost phase intercept not only reduces the number of ballistic missiles in post boost flight, but can cause missile debris to fall on enemy territory or fall short of the intended target(s). This could serve as a powerful deterrent against further development and proliferation, or actual use of chemical, biological, or nuclear warheads. Furthermore, as the range of ballistic missile threats increases and the types of warheads proliferate, the importance of boost phase intercept capability increases significantly. Intercept of a missile in its boost phase near the point of launch of the attack enables larger defended areas and simplifies the identification and discrimination problems associated with multiple warheads and threat penetration aids. The major objective of this program is to demonstrate

the required technologies in the relevant operational environment in order to establish TMD system utility. The BPI program also supports future National Missile Defense (NMD) objectives by developing the endoatmospheric kill vehicle technologies for ground based interceptors, which take advantage of atmospheric stripping of threat penetration aids. The program will leverage existing contracts and technologies currently under development, including the Israeli Boost Phase Intercept (BPI) study, to minimize schedule and costs, and is planned and conducted with BMDO, Air Force, Navy and Army elements to maximize user capabilities and interaction.

The demonstrations will validate critical technologies such as high velocity interceptor missiles with hit-to-kill capability and provide (1) new component and system capabilities with reduced costs/risks compared to current interceptor weapon systems, and enhancements to other interceptors under development, (2) reduction of costs and risks to support an acquisition program, and (3) technical solution for contingent residual boost phase intercept capabilities for theater defense. Advances in Kinetic Kill Vehicle (KKV) technology, concept development, and test planning activities have occurred with significant involvement by the Services.

4.3.2 Directed Energy Boost Phase Intercept

The Directed Energy Boost Phase Intercept Program consists of the Chemical Laser (CL) program and the Acquisition, Tracking, Pointing and Fire Control (ATP-FC) program. These high-power chemical laser components and technologies were developed over the past 15 years specifically for the boost phase intercept mission. These two programs were restructured in FY 1995 to reflect Congressional and Department of Defense (DoD) guidance.

Although not funded beyond FY 1997, BMDO is completing the Alpha/LAMP Integration (ALI) effort at the Capistrano Test Site in California. The Alpha laser, which achieved weapons-class (megawatt-class) operation in 1991, is being integrated with the high-power beam director which includes the 4-meter diameter Large Advanced Mirror Program (LAMP) primary mirror, the largest mirror ever built for use in space, along with adaptive optic and holographic beam control technologies. To conserve funds, testing of the Alpha laser will be suspended. The Alpha laser will be placed in a "maintenance only" mode during FY 1995 and remain inactive until the ALI program is ready to begin the high-power test phase in the first quarter of FY 1997. Following completion of the ALI integration and test activity the space based laser program is scheduled for cancellation.

4.3.3 Advanced Sensor Technology

This program is an evolutionary effort to improve tracking of ballistic missiles by improving surveillance sensors, and advancing signal processing techniques for efficient and definitive identification and discrimination. Development efforts emphasize compact, adaptable, efficient passive Focal Plane Arrays (FPAs) and precision active optical ranger/illuminators. Integrated detection/ signal processing demonstrations are scheduled for FY 1997.

Thereafter, the program develops the next generation of BMD sensing technology. Radar development efforts will emphasize miniaturized, adaptive techniques. Resources will also be used to develop data fusion and discrimination. Intermediate milestones address a building block approach of the system hardware and algorithm development. Airborne testing of these integrated technologies will begin in FY 1998. The ultimate objective will be achieved in a FY 2000 flight, using available aircraft platforms, that will demonstrate fusion of surveillance sensor data from

radar, Laser Detection And Ranging (LADAR), and Long Wavelength Infrared(LWIR) sensors with on board signal processing, tracking, and discrimination algorithms. The proof-of-principle detection, tracking, and discrimination demonstrations are planned to validate the maturity of technology prior to infusion into any acquisition program.

An effort related to the sensor program involves understanding the phenomenology associated with target signatures against different backgrounds. BMDO continues this critical technology program and has conducted a number of activities with our allies aimed at extending phenomenology data bases through acquisition and exchange.

4.3.4 Advanced Interceptor and System Technology

The Advanced Interceptor and System Technology (AIST) program is based on the fundamental premise that technology investment is not an option, but rather a requirement for achieving the BMDO mission. The focus of the program is therefore on providing technologies for BMDO elements which reduce technical risk, enhance capabilities and increase affordability. Technology insertion is accomplished through extensive ground, airborne, and space demonstrations. Four major categories are addressed:

- Technology which will insure high signal/noise images for interceptor and surveillance optical sensors: active and passive vibration control and use of non-contaminating optical baffles and low noise superconducting signal processing electronics;
- Development of lightweight, high stiffness, advanced composite structures and components which utilize low cost, single-step fabrication methodologies to provide cost-effective weight growth mitigation for all BMDO systems;
- Provide essential data to BMDO systems which enable design of effective sensor, surveillance and interceptor systems. This includes data on performance of critical microelectronic components in the space radiation environment; Medium Wavelength Infrared (MWIR) background/clutter data at high latitudes as a function of altitude and seasonal variation; micrometeorite and debris fluence at mission altitudes, response of key materials and coatings to the space environment, and basic engineering data on structural response and sensor window performance during ultrahigh-speed (>3 km/sec at 60 km altitude) endoatmospheric flight. BMDO tests on advanced materials for use in Infrared (IR) windows has included samples from several allied nations including the U.K. and Japan.
- Development of interceptor components necessary to achieve long-range threat detection, accurate homing guidance, and aim point selection for autonomous hit-to-kill interceptors. This includes high frame rate, high signal/clutter ratio passive infrared seeker, LADAR, and data fusion processing technologies. Emphasis is placed on increasing output power, miniaturization, and waveform generation to support on board imaging. Also included in this effort is the advancement of supporting interceptor technologies, such as Inertial Measurement Units (IMUs), propulsion, communications, and other subsystems that may be required to take full advantage of the improvements in the seeker technology. The ultimate objective will be achieved in interceptor flight tests in FY 2002 that will demonstrate on board fusion of active and passive data to detect, track, and discriminate. The proof-of-principle demonstrations are planned to validate the maturity of the tech-

nology and to demonstrate the reduced dependence of interceptors on external sensors to perform hit-to-kill, prior to infusion into any acquisition program.

The AIST program has effectively leveraged the expertise and resources of other agencies and allied nations in collaborative multinational, multiagency programs. This approach minimizes direct cost to BMDO and increases the effectiveness of technology development and demonstration efforts.

4.4 BMD Exploratory Science and Technology Program

The goal of the exploratory and science technology program is to identify, nurture, develop, demonstrate, and transition innovative ideas and approaches to ballistic missile defense technology. The projects sponsored by the program are structured to exploit science and technology to improve performance, weight and volume, producibility, and affordability of future BMD systems. Many examples of successful research, demonstration, and transition are already documented, while many new ones are in the pipeline. Figure 4-3 provides a compilation of many accomplishments for FY 1994. In addition, the highly successful Clementine satellite mission, described in Section 4.6, was managed under this program.

The exploratory and science technology program has two major thrusts: The Innovative Science and Technology (IS&T) contracted research program, and the Small Business Innovative Research (SBIR) program. Both are Research and Development (R&D) projects with the goals outlined above. In addition, the SBIR program has a strong legislatively directed commercialization emphasis. This is a key factor in selecting SBIR projects.

4.5 Technology Transfer and Dual Use

Much of the research pursued by the BMDO has broad application to meeting overall DoD needs and potential for civil and commercial applications. A second important objective is, therefore, to conduct a portion of the BMDO research efforts in a manner that enhances this technology transfer. For eight years, the Office of Technology Applications (OTA) within BMDO has focused on moving BMD technology out of the DoD and other Federal Laboratories and into the commercial market place and other agencies. It has been a model program, working closely with government, universities, and industry. To date, the OTA program has documented the following statistics from its commercialization efforts: 28 new spin-off companies started, 168 new products on the market, 204 patents granted, 149 patents pending, 231 new ventures (licensing agreements, strategic alliances, third party agreements, partnerships, etc.) started, 15 cooperative research and development agreements. Each of these emanates from a BMDO-sponsored technology.

Activities of BMDO's Small Business Innovative Research Program are a case in point. In FY 1993-1994, eight small firms with missile defense technology as their centerpiece raised nearly $100 million of new capital in the marketplace. The BMDO investment in these firms through the SBIR program totaled $12 million. Their current inferred valuation is over $500 million. Figure 4-3 describes a sampling of BMDO research technology accomplishments and their dual use potential.

Figure 4-3. BMDO Technology Accomplishments

Research Area And Accomplishments	Impact On BMD Capabilities	Potential For Military And Civilian Applications
Sensors		
• Superconducting Quantum Detector For High Sensitivity Focal Plane Array (FPA)	• Midcourse Detection, Low Noise Wavelength Division Multiplexer (WDM) Receivers For Test And Evaluation And Command And Control Centers	• Astronomical Observation, Low Noise WDM Receivers For The National Information Infrastructure (NII)
• SiGe / Si Heterojuncture Internal Photoemissive (HIT) Detectors	• Silicon Compatible FPAs Sensitive In The 6-12 Micron Region	• Commercial Remote Sensing
• Electron Tunnel Sensor	• Uncooled Sensor With The Sensitivity Of HgCdTe	• Commercial Remote Sensing
• Internal And Externally Cooled Infrared Windows	• Enables IR Seeker Operation At High Velocity And Low Altitude	• High-speed Air-to-Air Or Low Altitude And Cruise Missile
Optoelectronic Devices		
• High-speed Photonic Networks	• High Performance Computing And Communications For Test And Evaluation, Simulation And Battle Management, Command Control And Communictions (BM/C^3)	• National Information Infrastructure (NII)
• Terabyte Optical Storage	• Archival Storage For Test Data	• Large Public Data Bases, Digital Libraries, Medical, Commercial Video, And Other Archival Storage Media
Electronic Devices		
• Nonvolatile Semiconductor Random Access Memory (RAM)	• Long Life Memory For Theater Operations	• Wireless Communications Smart Highways
• Low Temperature (10 degrees Kelvin) Digital And Analog Superconducting Circuits	• Transceivers For Broadband Wireless Backbones For Telecommunications, High-speed Switching For Command And Control Centers (e.g., MMIC)	• Multimedia Centers
Computers		
• WASP 3-D Wafer Scale "Associative String" Reconfigurable Processor	• Graphics Engine For BM/C^3 And Test And Evaluation Workstation	• Visualization Engine For Multimedia
• 3DANN 3-D Analog Neural Network Processor	• Compact (1 cubic inch) Low Power (1W) Fast Frame Seeker	• Powerful Neural Network Processor For Real-time Image Processing And Robotics
• JPL Metacomputer	• Teraflop Performance For Distributed Simulation	• Teraflop Performance For Scientific Computation
Communications		
• Lasercomm 1 GHz Transceiver	• High Capacity Jam-less Backbone For Sensor-to-Sensor Satellite Downlinks	• Remote Sensing From Space
• Terahertz All Photonic Fiber Networks	• Terrestrial Backbones For BM/C^3 And Test And Evaluation	• National Information Infrastructure (NII)
• Broadband Millimeter Wave Transceiver	• Wireless Backbones For BM/C^3 And Test And Evaluation	• International Teleconferencing
Materials		
• Nonlinear Electro Optic Polymers	• Demonstrated For The First Time Room Temperature Spectral Hole Burning For Dense Memory	• High Capacity Cache For Teraflop Superconductors
• Wideband Gap Semiconductors	• Demonstrated True Blue Laser Diode, SiC Nonvolatile Random Access Memories (RAM)	• Thin Screen Color Display, Permanent Memory At RAM Access Speeds
• Nanorthographically Patterened Quantum Confined Semiconductor Materials	• Advanced Digital And Analog Devices For A Wide Variety Of Applications	• Advanced Digital And Analog Devices For A Wide Variety Of Applications
• Successful Sight Of STRV-1 U.S. / UK Microsatellites	• Improved Sensor Performance	• DoD, NASA Applications For Low Mechanical Noise Platforms
Rocket Propulsion		
• Solid Propellant Oxidizer (Ammonium Dinitride, ADH) With Higher Energy But Without Environmentally Questionnable Chlorine	• Reduces Booster Requirements By 10%, Eliminates Environmental Concerns, Improves Control Of Thrust Profile	• Being Considered As Replacement Propellant For Shuttle Carried Low Earth To Geosynchronous Transfer Motors
• Energetic Oxetane Thermoplastic Elastomers	• Propellant Manufacturing Defects Corrected By Reheating And Recasting, Waste And Reclaimed Propellant Reused Without Penalty	• Tri-service Interest Building, Integral Part Of Several IR&D Programs
• High-G Solid Divert And Altitude Control Propulsion	• Navy Safe Propulsion For Hit-to-Kill Interceptor Systems	• Highly Maneuverable Missile Systems Inside Or Outside Atmosphere
• Multiple Pulse Axial Motors	• Reduces Divert Requirements On Hit-to-Kill Interceptors	• Flexible Energy Management For Space Motors
Power		
• Solar Array Technology That Includes Concentrators And Dual Band-gap Photovoltaic Materials	• 40% Reduction In Mass, 60% Reduction In Cost, Van-allen Radiation Resistant	• Cooperative Program With NASA And Air Force, Flight Demonstration Tests Being Augmented By Communication Satellite Companies

4.6 Significant Accomplishments in 1994

Some advanced technology accomplishments for 1994 are briefly highlighted below. These accomplishments are representative of BMDO's Advanced Technology Program and illustrate the broad spectrum of activities required to support TMD.

The Clementine satellite project, launched in February 1994 and accomplished at a total cost of $80M, was a two-year program to test 23 advanced technologies useful for missile defense. Many of the new technologies were novel sensors and signal processors that used the moon as a target to demonstrate their imaging capabilities. Over 1.8 million images of the lunar surface were returned to earth in the ultraviolet, visible, mid- and long wavelength infrared regions of the spectrum. A miniature laser radar measured the topology of the entire lunar surface to better than 40 meters.

Other images of the moon were taken with advanced cameras using exotic materials such as indium antimonide to record the pictures. These modern detectors will find applications in several BMDO interceptors and sensor systems. The amazing fact about this new sensor technology is how lightweight it is: the entire package of five sensors on Clementine weighed only 18 pounds. Other advanced technologies flown in space for the first time include a battery which provides power at one-fourth the weight of its predecessor; solar arrays for generating electricity that are one-third the thickness of earlier arrays; and commercial-off-the-shelf technologies, including 4-megabit Dynamic Random Access Memories (DRAMs) and a 32-bit Reduced Instruction Set Computer (RISC) for processing images. Because of the success of Clementine, some of these 23 new technologies are now flight qualified for use in today's BMD systems.

The eleventh successful high-power test of the Alpha/LAMP Integration (ALI) program was completed this summer at the Capistrano Test Site in California. The ALI facility, including the vacuum chamber for LAMP, and the 64 ft by 24 ft ALI Optical Bench were completed and their performance was validated during testing. New coatings and gratings were applied to the 4-meter Large Advanced Mirror Program (LAMP) mirror segments and transmissive beam sampling was demonstrated at high power with single crystal silicon optics. These uncooled, lightweight optics significantly reduce the laser system's weight, cost, and complexity. Machining of a full scale single crystal silicon inner cone assembly for the laser resonator and the fabrication of a partial scale silicon annular optics were completed. These efforts confirm the technology readiness of production size uncooled optics. The fabrication of a flowing Stimulated Brillouin Scattering (SBS) cell was completed and high-pressure medium homogeneity was demonstrated with high molecular weight Xenon stimulants in the Advanced Phase Conjugation Experiment (APEX) technology program. This phase correction technology will enable the formation of a brighter high-power laser beam which could significantly enhance the laser system performance. The fabrication was completed on the Overtone Research Advanced Chemical Laser Hypersonic Low Temperature (ORACL HYLTE) gain generator module for an High Frequency (HF) overtone laser. This overtone technology offers the promise of being able to develop the high-power laser at shorter wavelengths which could significantly enhance the performance of the laser system.

The Advanced Beam Control System (ABCS) program demonstrated automated alignment of a wide-field-of-view three-mirror telescope (subscale prototype). The experiment demonstrates the initial feasibility of autonomous control of advanced high energy laser systems for space applications.

The Large Optical Segment (LOS) program, after successfully demonstrating fabrication of a 4-meter-diameter petal of an 11-meter segmented primary mirror continued with the fabrication of the 4-meter center segment.

The Acquisition, Tracking, Pointing and Fire Control (ATP-FC) program:

- Demonstrated active control of structural disturbances on the Space Integrated Controls Experiment (SPICE) test bed. Achieved a jitter rejection ratio surpassing the previous state-of-the-art and the program goal;
- Completed development, delivery and acceptance testing of an Inertial Pseudo-Stellar Reference Unit (IPSRU) capable of pointing a low-power laser alignment beam with extreme precision in inertial space;
- Continued design and fabrication of a High Altitude Balloon Experiment (HABE) payload to demonstrate an end-to-end engagement against a TMD target.

BMDO and the Services have successfully evaluated several critical technologies that support the BPI Program under TMD funding in FY 1994. The BPI program initiated concept of operations development, intercept test planning, and Kinetic Kill Vehicle (KKV), booster, and kickstage development; conducted KKV window thermal optical tests and hyperthermal facilities; and completed fabrication of KKV structural forebodies for testing to enable design of the guidance and control for high-speed endoatmospheric flight.

BMDO achieved significant progress in developing Lightweight Exoatmospheric Projectile (LEAP) interceptor systems for integration with Navy Standard Missile (SM) and shipboard combat systems as part of the Navy Theater Wide Program to prove the feasibility of using flexible naval forces for intercepting Theater Ballistic Missile (TBM) targets outside the atmosphere. A solid divert LEAP interceptor, compatible with Navy shipboard safety requirements and equipped with a Long Wavelength Infrared (LWIR) seeker for long-range target acquisition, was successfully hover tested. Flight qualification was accomplished for major LEAP/SM subsystems, including the Advanced Solid Axial Stage (ASAS) kickstage, Global Positioning System (GPS)/ Inertial Navigation System (INS), Attitude Control System (ACS), and LEAP interceptor. The successful Navy LEAP target demonstration flight test validated the program target as TMD threat representative. Safety certification for LEAP interceptor operations on board ship was completed, and LEAP interceptor integration with the Navy SM continued in preparation for two FY 1995 at-sea intercepts (FTV-3, FTV-4) of a TMD target. Planning also was initiated for execution of an exoatmospheric controllability demonstration of a SM-2 Block IV missile from an AEGIS ship at sea.

The final planned flights of the Single Stage Rocket Technology (SSRT) Delta Clipper Experimental (DC-X) were successfully executed and expanded the flight envelope to increasing altitudes and flight durations. These successes demonstrated the application of current technology to resolution of high cost space launch through a single stage reusable rocket system designed around a minimal operating crew and maintenance requirements. The DC-X has been transferred to the National Aeronautics and Space Administration (NASA) for continued development.

Long-lived spaceflight-compatible cryogenic coolers have been developed for low temperature infrared sensor operations. A cooling capability to 60 degrees kelvin was achieved with a 95 percent reliability design for an expected lifetime of over 10 years. Also, fabricated and demonstrated was a miniature, single stage turbine cooler operating at temperatures as low as 35 degrees kelvin for increased long infrared sensor performance. Very long wave infrared sensor arrays operating out to 26 micrometers were fabricated and achieved nearly noise free gain, allowing for detection, tracking and discrimination of very cold targets as well as increased range for standard warheads.

An integrated CO_2 laser radar transmitter and receiver was demonstrated at the Army Missile Optical Range (AMOR). This system successfully discriminated between a simulated target and decoy) validating sensor design approach and discrimination algorithms.

The Space Test Research Vehicle (STRV)-1a and -1b microsatellites were launched on June 17, 1995 into a geo-transfer orbit. A key BMDO experiment is demonstration of adaptive structures vibration suppression, using a tactical cryocooler as the vibration source. Data show reduction of vibration levels by a factor of 100, equal to the best results obtained in ground tests. As a side benefit, the cryocooler has been validated for space use and future space tests requiring low temperatures for relatively short periods of time (approximately one thousand hours) may choose to use a low cost tactical cryocooler rather than an expensive long-life space cryocooler. Extremely interesting and valuable data are being obtained on the radiation levels encountered in the Van Allen belts as functions of altitude and solar activity by an Electronically Scanned Array (ESA) radiation detector mounted on the STRV-1b. These data are significantly increasing our understanding of the dynamics of these radiation fields and their effect on satellite systems. This program has been conducted with major inputs from the United Kingdom (U.K).

The second Miniature Sensor Technology Integration (MSTI) program satellite, MSTI-2, was launched from Vandenberg AFB on May 8, 1994. Its mission contributed to an improved understanding of the technical challenges associated with ballistic missile launch detection and tracking, including sensor miniaturization and test of innovative sensing concepts. Highlights of the mission include the successful acquisition and track of a Minuteman III operational test launch out of the Western Test Range; observation attempts on two Sergeant Target launches out of Wallops Island; multiple tracking observations of various ground test objects; and collection of over three million images of shortwave and midwave infrared background scenes. In addition to its primary TMD space based sensor demonstration role, MSTI-2 was also able to achieve connectivity to Navy shipboard assets in a theater space based queuing demonstration.

With an eye to the future when new technologies must replace today's technologies, BMDO invested in research to find what is possible, mixing exploratory research and advanced development with technology demonstrations. Such research aims at shrinking the weight, power, and volume of antimissile technology, at sensors that leapfrog the current state-of-the art in detecting hostile missiles, and at materials with entirely new capabilities. In most cases these technologies will also open new possibilities for commercial dual use purposes.

Chapter 5

Program Funding

Chapter 5
Program Funding

5.1 Funding Summary

The FY 1994 National Defense Authorization Act sets forth specific Ballistic Missile Defense Defense Organization (BMDO) Program Elements (PEs) for presenting the BMDO budget justification materials for any fiscal year after FY 1995. As stated in the accompanying Congressional language, the intent was to establish separate line items which would include all funds for each item irrespective of whether the funds were attributed to exploratory development, demonstration/ validation, engineering/ manufacturing development, or procurement. The Congressional guidance went on to direct that beginning in FY 1996, to the extent possible, test and evaluation and other direct supporting activities associated with specific Theater Missile Defense (TMD) systems should be requested as a project or task within the appropriate program element.

In response to the Congressional guidance, BMDO has substantially adjusted its budget presentation. The TMD programs have been individually established and the National Missile Defense (NMD) program is separately defined from other Technology programs. To support the Department's needs, the P.E.s are structured to retain visibility by appropriation (RDT&E, Procurement, and MILCON), and by Research, Development Test and Evaluation (RDT&E) Budget Activity (i.e. exploratory development, demonstration/validation, and engineering/manufacturing development). However, in addition, a composite funding perspective, combining all project funding, has also been provided as part of the budget justification materials to provide the visibility requested by the Congress. Figure 5-1 summarizes the total program funding by program element.

In addition to the adjustment in the program element structure, projects have also been redefined to implement the Congressional guidance. The degree of change in project definition varies by project but, to distinguish the previous project structure from the current structure, all projects have been reidentified. Figure 5-2 lists the current projects and provides a funding summary by project. Appendix A provides a narrative description of the activities planned, recent accomplishments, and funding plans for each project. The Congressional Descriptive Summaries (CDSs) provided in support of the FY 1996 President's Budget request describe this information in greater detail.

Figure 5-1. Program Element Summary (In Millions Of Then Year Dollars - Rounded)

Project Number And Title			FY 1995* Request	FY 1995 Appropriated	FY 1995** Current Estimate	FY 1996** Request	FY 1997 Programmed
PE 0208861C / 0603861C / 0604861C THAAD System							
2260	THAAD	RDT&E	496	470	480	414	524
		MILCON	0	0	0	14	5
2154	TMD-GBR	RDT&E	0	0	0	163	212
		Total	496	470	480 (Includes T&E Support)	590	741
PE 0603862C / 060486CC TMD-GBR (Combined With THAAD In Single PE Beginning In FY 96)							
2154	TMD-GBR	RDT&E	173	173	172	0	0
		Total	173	173	172	0	0
PE 0208863C / 0603863C HAWK							
2358	HAWK System BM/C3	RDT&E	27	27	27	23	0
		Proc	4	4	4	5	20
		Total	31	31	31	28	20
PE 0208864C / 0603864C / 0604864C BM/C3I							
3261	BM/C3I Concepts	RDT&E	34	21	21	39	42
		Proc	0	0	0	32	20
		Total	34	21	21	71	63
PE 0208865C / 0603865C / 0604865C PATRIOT Advanced Capability Level-3 Missile (PAC-3)							
2257	PATRIOT	RDT&E	286	286	276	248	160
		Proc	255	255	253	399	414
		Total	541	541	529	647	574
PE 0604866C PAC-3 Risk Reduction							
2257	PATRIOT	RDT&E	0	74	74	19	10
		Total	0	74	74	19	10

* FY 95 Appropriations Act Specified Revised PEs For Future Budget Justification. Column Reflects Realignment To Correspond To Specified PEs

** President's Budget Request

Note: Totals May Not Add Due To Rounding

Figure 5-1. Program Element Summary (Cont'd)
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title		FY 1995* Request	FY 1995 Appropriated	FY 1995** Current Estimate	FY 1996** Request	FY 1997 Programmed
PE 0208867C / 0603867C / 0604867C						
Navy Lower Tier Missile Defense						
2263 Sea Based Area Defense						
	RDT&E	180	140	140	237	193
	Proc	14	14	14	17	92
	Total	194	154	154	254	285
PE 0603868C						
Navy Upper Tier Missile Defense						
1266 Sea Based Theater Wide						
	RDT&E	18	75	68	30	33
	Total	18	75	68	30	33
PE 0603869C						
Corps Surface-to-Air Missile						
2262 MEADS (Formerly Corps SAM)						
	RDT&E	18	15	15	30	33
	Total	18	15	15	30	33
PE0603870C						
Boost Phase Intercept Program						
1265 BPI						
	RDT&E	61	40	40	49	44
	Total	61	40	40	49	44
PE 0603872C						
Other TMD Activities (RDT&E Except As Noted)		***	***			
1155 Phenomenology				40	44	53
1161 Advanced Sensor Technology				3	4	4
1170 TMD Risk Reduction				26	46	40
2160 TMD Existing System Mods				16	27	25
2259 Israeli Cooperative Projects				48	57	44
3151 Architecture Analyses / BM/C³ Initiatives				5	9	9
3157 Environ. Siting And Facil.						
	RDT&E			0	4	4
	MILCON			0	3	3
3160 Deployment Planning				1	2	2
3251 Systems Engr And Tech Supp				53	48	57
3265 User Interface				12	17	17
3270 Threat And Countermeasures				0	25	25
3352 Modeling And Simulation				65	71	58
3354 Targets Support				64	26	30
3359 System T&E				28	47	47
3360 Test Resources				26	34	36
	Total	479	382	387	460	450

* FY 95 Appropriations Act Specified Revised PEs For Future Budget Justification. Column Reflects Realignment To Correspond To Specified PEs
** President's Budget Request
*** Redefined Project Structure
Note: Totals May Not Add Due To Rounding

Figure 5-1. Program Element Summary (Cont'd)
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title	FY 1995* Request	FY 1995 Appropriated	FY 1995** Current Estimate	FY 1996** Request	FY 1997 Programmed
PE 0603871C					
National Missile Defense (RDT&E Except As Noted)	***	***			
1151 Sensors (Active And Passive)			107	103	89
1155 Phenomenology			31	15	18
1267 GBI			138	127	150
1460 BM/C3			28	34	36
3152 NMD Systems Engineering			20	19	18
3153 Architecture Analyses / BM/C3 Initiatives			0	3	3
3157 Environ Siting And Facilities RDT&E			0	1	1
MILCON			1	1	1
3160 Deployment Planning			13	14	17
3265 User Interface			1	1	2
3270 Threat And Countermeasures			0	8	8
3352 Modeling And Simulation			19	16	27
3359 System T&E			14	18	18
3360 Test Resources			12	11	12
4000 Operations Fluctuations Acc't			3	0	0
Total	(Combined With Support Technologies)	399	387	371	400
PE 0602173C / 0603173C					
Support Technologies (RDT&E Except As Noted)	***	***			
1155 Phenomenology			6	0	0
1161 Advanced Sensor Technology			10	24	28
1270 Advanced Interceptor And System Technology			15	24	26
1360 Directed Energy Programs			42	30	30
1651 IS&T			46	51	53
1660 Statutory And Mandated Programs			43	47	57
2259 Israeli BPI			3	0	0
3153 Architecture Analyses / BM/C3 Initiatives			8	0	0
3157 Environ. Siting And Facilities			6	0	0
3270 Threat And Countermeasures			30	0	0
3352 Modeling And Simulation			3	0	0
3360 Test Resources			7	0	0
Total	769 (Includes NMD)	225	219	173	193

* FY 95 Appropriations Act Specified Revised PEs For Future Budget Justification. Column Reflects Realignment To Correspond To Specified PEs
** President's Budget Request
*** Redefined Project Structure
Note: Totals May Not Add Due To Rounding

Figure 5-1. Program Element Summary (Cont'd)
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title	FY 1995* Request	FY 1995 Appropriated	FY 1995** Current Estimate	FY 1996** Request	FY 1997 Programmed
PE 0605218C					
Program Management					
4000 Personnel And Management Support	215	198 (Includes T&E Support)	163	186	188
Total	215	198	163	186	188

* FY 95 Appropriations Act Specified Revised PEs For Future Budget Justification. Column Reflects Realignment To Correspond To Specified PEs

** President's Budget Request

Figure 5-2. Current Project Funding Profile (In Millions Of Then Year Dollars)

Project Number And Title	Funds Through FY 1994	FY 1995* Estimate	FY 1996* Request	FY 1997 Programmed
1151 Sensors (Active / Passive)	131**	107	103	89
1155 Phenomenology	87**	78	59	70
1161 Advanced Sensor Technology	111**	13	27	32
1170 TMD Risk Reduction	14**	26	46	40
1265 Boost Phase Interceptor	40	40	49	44
1266 Sea Based Theater Wide Defense	81	68	30	33
1267 Ground Based Interceptor	69	138	127	150
1270 Advanced Interceptor Systems Technologies	13**	15	22	26
1360 Directed Energy Programs	75**	42	30	30
1460 BM/C^3 (NMD)	24	28	34	36
1651 Innovative Science And Technology	726	46	51	53
1660 Statutory And Mandated Programs	296	43	47	57
2154 TMD-GBR	779	172	163	212
2160 TMD Existing System Modifications	20**	16	27	25
2257 PATRIOT (Includes Risk Reduction Program)	943	604	666	584
2259 Israeli Cooperative Projects	183	51	57	44
2260 THAAD	822	480	427	529
2262 MEADS (Formerly Corps SAM)	61	15	30	33
2263 Sea Based Area Defense	215	154	254	285
2358 HAWK System BM/C^3	30	31	28	20
3152 NMD System Engineering	41**	20	19	18

* President's Budget Request
** Redefined Project - Reflects FY 1994 Funding Only

Figure 5-2. Current Project Funding Profile (Cont'd)
(In Millions Of Then Year Dollars)

Project Number And Title	Funds Through FY 1994	FY 1995* Estimate	FY 1996* Request	FY 1997 Programmed
3153 Architecture Analysis / BM/C^3 Initiatives	12**	12	12	12
3157 Environment, Siting And Facilities	37	6	9	9
3160 Readiness Planning	8**	15	16	19
3251 Systems Engineering And Technical Support	33**	53	48	57
3261 BM/C^{3}I Concepts	36	21	71	63
3265 User Interface	15	13	18	18
3270 Threat And Countermeasures Program	31**	30	33	33
3352 Modelling And Simulation	109**	87	86	84
3354 Targets Support	84**	64	26	30
3359 System Test And Evaluation	49**	42	65	65
3360 Test Resources	39**	44	46	48
4000 Operational Support	2,137	167	186	188

* President's Budget Request
** Redefined Project - Reflects FY 1994 Funding Only

Chapter 6

ABM Treaty Compliance

Chapter 6
ABM Treaty Compliance

6.1 Introduction

The 1972 Antiballistic Missile (ABM) Treaty addresses the development, testing, and deployment of ABM systems and components. The Administration reaffirmed the traditional, or the narrow interpretation of the ABM Treaty in a July 13, 1993 letter to Congress. It should be noted that use of the word "research" does not appear in the ABM Treaty and research is not constrained by the Treaty. Neither the United States nor the Soviet delegation to the Strategic Arms Limitation Talks (SALT I) negotiations chose to place limitations on research, and the ABM Treaty makes no attempt to do so. The United States has traditionally distinguished "research" from "development" as outlined by then-U.S. delegate Dr. Harold Brown in a 1971 statement to the Soviet SALT I delegation. Research includes, but is not limited to, concept design and laboratory testing. Development follows research and precedes full-scale testing of systems and components designed for actual deployment. Development of a weapon system is usually associated with the construction and field testing of one or more prototypes of the system or its major components. However, the construction of a prototype cannot necessarily be verified by national technical means of verification. Therefore, in large part because of these verification difficulties, the ABM Treaty prohibition on the development of sea based, air based, space based, and mobile land based ABM systems, or components for such systems, applies when a prototype of such a system or its components enters the field testing stage.

6.2 Existing Compliance Process For BMDO

The Department of Defense (DoD) has in place an effective compliance process (established with the SALT I agreements in 1972) under which key offices in DoD are responsible for overseeing BMD compliance with all the United States arms control commitments. Under this process, the Ballistic Missile Defense Organization (BMDO) and DoD components ensure that the implementing program offices adhere to DoD compliance directives and seek guidance from offices charged with oversight responsibility.

Specific responsibilities are assigned by DoD Directive 2060.1, July 31, 1992, "Implementation of, and Compliance With, Arms Control Agreements". The Under Secretary of Defense (Acquisition & Technology), USD(A&T), ensures that all DoD programs are in compliance with the United States arms control obligations. The Service Secretaries, the Chairman of the Joint Chiefs of Staff, and agency directors ensure the internal compliance of their respective organizations. The DoD General Counsel provides advice and assistance with respect to the implementation of the compliance process and interpretation of arms control agreements.

DoD Directive 2060.1 establishes procedures for ensuring the continued compliance of all DoD programs with existing arms control agreements. Under these procedures, questions of interpretation of specific agreements are to be referred to the USD(A&T) for resolution on a case-by-case basis. No project or program which reasonably raises a compliance issue can enter into the testing, prototype construction, or deployment phase without prior clearance from the USD(A&T). If

such a compliance issue is in doubt, USD(A&T) approval is sought. In consultation with the office of the DoD General Counsel, Office of the Under Secretary of Defense (Policy), and the Joint Staff, USD(A&T) applies the provisions of the agreements as appropriate. DoD components, including BMDO, certify internal compliance periodically and establish internal procedures and offices to monitor and ensure internal compliance.

In 1985, the United States began discussions with allied governments regarding technical cooperation on BMD research. To date, the United States has concluded bilateral BMD research Memoranda of Understanding (MOU) with the United Kingdom, Germany, Israel, Italy, and Japan. All such agreements will be implemented consistent with the United States' international obligations including the ABM Treaty. The United States has established guidelines to ensure that all exchanges of data and research activities are conducted in full compliance with the ABM Treaty obligations not to transfer to other states ABM systems or components limited by the Treaty, nor to provide technical descriptions or blueprints specially worked out for the construction of such systems or components.

6.3 BMDO Experiments

All BMDO field tests must be approved for ABM Treaty compliance through the DoD compliance review process. The following major programs and experiments, all of which involve field testing, have been approved and are to be conducted during the remainder of FY 1995 and FY 1996: flights throughout FY 1995-1996 in the Airborne Surveillance Testbed (AST) program, a revision of the Airborne Optical Adjunct (AOA) project; High Altitude Balloon Experiments (HABE); the Midcourse Space Experiment (MSX); AEGIS SPY-1 radar and STANDARD Missile (SM-2 Block IV) modifications (Navy Area Defense Program); HAWK and TPS-59 radar upgrades; Skipper; Miniature Sensor Technology Integration (MSTI) Satellite Development Program MSTI-3; PATRIOT PAC-3 system (with either the Multimode Missile (MMM) or Extended Range Intercept Technology (ERINT) missile); PATRIOT PAC-3/ ERINT system EMD flight tests; Theater High Altitude Area Defense (THAAD) interceptor Demonstration and Validation (Dem/Val) flight tests 1-14; Terrier [Navy] Lightweight Exoatmospheric Projectile (LEAP) FTV 3-4; Ballistic Missile Early Warning System (BMEWS) Radar Battle Management/Command, Control, Communications (BM/C^3) Tracking Demonstration (formerly called the RAF Fylingdales BMEWS Tracking Experiment); Endoatmospheric Aerothermal Mechanics Flight Experiments (EFEX); Space Test Research Vehicle 2 (STRV-2); Space Test Experiment Platform (STEP) Mission 3; Rapid Response Air Defense (RRAD) program; Space and Missile Tracking System (SMTS)(formerly Brilliant Eyes) Flight Demonstration System (FDS). For the Israeli Arrow interceptor development program known as the Arrow Continuation Experiments (ACES) compliance guidance has been provided.

In addition, the following data collection activities are approved: High Altitude Observatory (HALO) aircraft; Cobra Judy; Theater Missile Defense (TMD) Critical Measurements Program (TCMP) II; Rapid Optical Beam Steering (ROBS) System (formerly called the Transportable LADAR System); Russian-American Observation System (RAMOS); Countermeasures Skunkworks flight tests 3-8; Red Tigress III; TMD SITs 95-1, 96-1A, and 96-1B, and the TMD C^3 program

The following projects are approved activities that are not considered to be in field testing: Alpha/LAMP Integration (ALI); and the High Energy Laser System Test Facility (HELSTF) experiments and data collection activities. Also, the National Test Bed (NTB) including the Experiment Control Center (ECC) has been determined to be compliant with the ABM Treaty.

The following target development projects have been approved: Strategic Target System (STARS); Operational and Developmental Experiments Simulator (ODES); Storm Ballistic Tactical Target Vehicle (BTTV) and Maneuvering Tactical Target Vehicle (MTTV) flights (formerly called the ERINT Target System development project); and the Hera "B" target vehicle. All BMDO launches are reviewed for compliance with the research and development launch provisions of the 1987 Intermediate Range Nuclear Forces Treaty. Such launches will be notified to the Nuclear Risk Reduction Center of the Former Soviet Union (FSU) as required.

Changes to the above approved experiments and programs are required to be reviewed for compliance implications.

The following programs, some of which have not been sufficiently defined for compliance certification, are not yet approved: THAAD User Operational Evaluation System (UOES), and Engineering and Manufacturing Development (EMD) program (includes interceptor and Theater Missile Defense-Ground Based Radar (TMD-GBR)); Corps SAM; Boost Phase Intercept (BPI) program; MSTI-Pave Paws Integration Experiment; Exoatmospheric Kill Vehicle (EKV) flight tests (FY 1997-1999) (formerly the Ground Based Interceptor); Ground Based Radar Radar Technology Demonstrator (RTD) program; and Airborne Warning And Control System (AWACS) Extended Airborne Global launch Evaluator (EAGLE).

As required by the National Defense Authorization Act for Fiscal Year 1995, DoD submitted ABM Treaty compliance review reports on the following systems: SMTS (formerly Brilliant Eyes) and the Navy Theater Wide System (formerly the Navy Upper Tier System). The Navy Theater-wide Tactical Ballistic Missile Defense (TBMD) report concluded that, "Since the baseline Navy Theater-wide TBMD system does not have 'capabilities to counter strategic ballistic missiles' and assuming it will not be 'tested in an ABM mode', then deployment would not be limited under the Treaty." For the Space and Missile Tracking System the report states that, "... if certain conditions are met, the development, testing, and deployment of SMTS, to support either an ABM system for NMD or an anti-tactical ballistic missile (ATBM) system for TMD, or both, would be consistent with the ABM Treaty."

Chapter 7

International Coordination And Consultation

Chapter 7
International Coordination And Consultation

7.1 Introduction

The United States is exploring possibilities for cooperation in the development and deployment of Theater Missile Defenses (TMD) with many of its allies, friends, and even former adversaries who share the concern arising from the proliferation of ballistic missiles. The Department of Defense (DoD) plans to cooperate in the development and production of capabilities as well as coordinate development and implementation of U.S. TMD programs with those of allies and friends with the goal of enhancing the effectiveness of TMD, increasing interoperability and reducing costs.

7.2 Allied Consultations and Participation In Ballistic Missile Defense Programs

The Department of Defense approach to international participation in the development and deployment of TMD systems builds on an earlier foundation and continuing efforts in the area of bilateral Research and Development (R&D) programs. These R&D programs were intended and continue to bring highly advanced technologies from abroad, i.e., from friends and allies, into the research effort together with a better understanding of political and military factors that would influence the defense architecture in various regions around the globe. Moreover, such participation provides our friends and allies added insights with which to make informed decisions regarding their own missile defense requirements.

The result of cooperative R&D programs has been a wider agreement on the likelihood and impact of the use of missiles in a theater conflict and the recognition of the need for the development of an effective, layered response to that threat. The actions of Iraq in Desert Storm underlined the consequences of ballistic missile attacks by a hostile nation in a regional conflict.

Other nations now recognize the existing and emerging threats of ballistic missile attack and, as a consequence, commitments to TMD-related activities by our friends and allies have been increasing. Even our earlier adversary, the former Soviet Union, continues to invest in TMD capabilities and is examining ways in which it can coordinate efforts with the United States. These commitments are evidenced both in unilateral actions by individual nations and multilaterally through the North Atlantic Treaty Organization (NATO) Alliance.

Facing the most imminent threat, Israel, with the cooperation of the United States, has long pursued a Ballistic Missile Defense (BMD) program centered around the Arrow missile. In Asia, the proliferation of ballistic missiles has prompted the Japanese government to enter into bilateral discussions with the United States on missile defense, and we are currently engaged in a bilateral study on ballistic missile defense for Japan. The Australian Government, in its 1994 Defence White Paper, listed the prevention of ballistic missile proliferation as a policy priority and identified ballistic missile defense as a potential area for scientific cooperation with the United States.

Similarly, Canada has recently indicated that it is interested in gaining a better understanding of missile defense through research in consultation with like-minded allies.

In November 1994, the Technical and Aerospace Committee of the Western European Union (WEU) issued a report recognizing the need for Europe to determine the security risks posed by the proliferation of ballistic missiles and recommended that the WEU "discuss the possibilities of cooperation between the United States and Europe on antimissile defense."

In addition to long-term support of U.S. BMD R&D activities, the United Kingdom (U.K.) has recently initiated a study related to their requirements for national and forward-deployed missile defenses. Similarly, the French, in their 1994 White Paper (their first defense white paper in 22 years), have called for a redirection of research resources to BMD activities. Likewise, the 1994 German White Paper on defense highlights the dangers of increasing proliferation and calls for the build-up of a tactical missile defense capability.

In addition to several NATO studies on BMD, a NATO working group of eight nations (the United States, the United Kingdom, Germany, France, Canada, Netherlands, Norway, and Italy) has been established under the Conference of National Armaments Directors. This ad hoc working group has been chartered to deal exclusively with finding ways to cooperate in TMD programs. This effort is complementary to those of the NATO Military Authorities, who have prepared a military requirement for TMD, and the Defense Group on Proliferation, who is establishing the policy framework for active defense as an element in the Alliance's overall approach to counterproliferation.

To capitalize on this interest through all possible modalities of participation, including bilateral and multilateral programs, an evolutionary and tailored approach to accommodate varying national programs and plans, as well as the special capabilities of particular nations, is being taken. The approach may range from measures such as sharing early warning information to continued bilateral or multilateral R&D, to improvements to current missile defense capabilities, to more robust participation such as codevelopment and coproduction programs and subsequent deployment of advanced capabilities. Benefits of such international programs to enhance missile defense capabilities would include increased regional security; potential cost reductions for U.S. programs (to include reduced requirements for foreign deployments); improved security relationships; and enhanced operational interoperability as nations plan to procure and deploy defenses.

7.3 TMD Coordination Plan

7.3.1 DoD TMD Acquisition Strategy

To succeed, our allied TMD strategy must be complementary to the existing DoD TMD Strategy. DoD's TMD acquisition strategy consists of three phases. In the first, near term improvements are aggressively pursued by enhancing existing systems using low risk, low cost, and quick reaction programs while simultaneously developing and refining TMD concepts of operation and tactics. In the second phase, a prudent acquisition approach is employed to procure a significant core TMD capability consisting of land based defenses to protect critical assets and to provide theater-wide protection. The core capability also includes a sea based defense to protect U.S. and friendly

forces in ports and littoral areas. The core program utilizes User Operational Evaluation Systems (UOESs) (essentially deployable prototypes) to provide an early contingency capability. In the final phase, advanced concept technology demonstrations and other risk reduction activities are used to develop advanced concepts to complement the core program with the emphasis on affordability and new technologies.

7.3.2 Near To Mid Term Allied Strategy

A key tenet in DoD's TMD program is the development of missile defense capabilities in an evolutionary manner, e.g., improving PATRIOT capabilities by deploying PATRIOT Advanced Capability Level-3 (PAC-3), and building on existing AEGIS capabilities by adding the Standard Missile Block IVA to provide a sea based lower tier defense against shorter range Theater Ballistic Missiles (TBM). This strategy is being extended into our foreign discussions with those nations operating export versions of U.S. equipment, producing U.S. systems under license, or contemplating possible codevelopment or acquisition of U.S. equipment in the future. The plan to coordinate development and implementation of TMD programs with friends and allies has the goal of avoiding duplication, reducing costs, and increasing interoperability.

This plan is the evolutionary approach that builds on the success of earlier programs, to include those sponsored by external organizations such as NATO. The plan proceeds from a foundation where the responsible political and military authorities set forth the need for defenses. Coordination is effected (e.g., by the NATO Air Defense Committee) to ensure that TMD is properly integrated into the existing air defense and airspace command/control systems. The plan draws on the results of numerous baseline analyses such as NATO's Advisory Group on Aerospace Research and Development (AGARD) and the Ballistic Missile Defense Organization (BMDO) supported missile defense architecture studies for Europe, the Middle East and Japan. It includes the definition of technology alternatives as identified in these baseline architecture studies and further supplemented by reports such as those prepared by the NATO Industrial Advisory Group (NIAG). As individual nations complete their own studies (Israel has finished, the United Kingdom, Japan, and France are underway), bilateral discussions provide the basis for future cooperative actions. The near to mid term program identifies the potential for immediate, low cost, low development, feasible improvements to existing systems and or operational concepts that will result in measurable improvement in early warning and TMD capability.

The near to mid term strategy attempts to build on existing capabilities listed and establishes the way ahead for incremental improvement and or the introduction of new capabilities. Key to initial improvements is the dissemination of ballistic missile launch information. Therefore, the first element of the DoD plan for international coordination includes the delineation of all current early warning capabilities and the current planned and possible future means to share the information from these systems. Specifically, this would include the following:

- Examination of current space based sensors and the means to share their data;
- Identifying ground and sea based sensor capabilities for theater surveillance (U.S. and foreign) and associated modifications to enable improved detection and tracking of missiles. This element of the program should include the integration of U.S. maritime and ground based assets with foreign systems to provide an improved surveillance capability for a particular region. Programs would include consideration of U.S. AEGIS sensors (AN/SPY-1 radar), forward deployed ground based

radars such as the AN/TPS-59 or the export version, the FPS-117, and other national or Alliance air defense and missile defense surveillance systems;

- Pursuing possible modification of airborne surveillance systems, such as fitting the E-3 Airborne Warning and Control System (AWACS) with an infrared search and track capability, to provide more precise tracking of ballistic missiles. We are trying to develop a cooperative program with NATO, the United Kingdom and France (who already have operational aircraft) for the first step, namely, a flight demonstration;

- Determination of the adequacy of existing Battle Management/Command, Control, Communications and Intelligence (BM/C^3I) systems (and planned improvements), e.g., the NATO Airspace Command/Control System (ACCS), to handle the short time-of-flight ballistic missile threats; specifically, implementation of standard message formats and message protocols to ensure the most rapid and efficient exchange of information. Changes will be made to Joint Tactical Information Distribution System (JTIDS) messages to support Cueing, Command & Control, and Situational Awareness. Tactical Ballistic Missile Defense (TBMD) messages derived for current JTIDS use will be incorporated into the NATO Improved Link Eleven System (NILES) as NILES development progresses between NATO countries;

- The identification of evolutionary command and control operational concepts, such as the Navy Cooperative Engagement Capability (CEC) and their possible integration into Allied forces;

- The distribution of improved early warning information which could significantly enhance the performance, i.e., coverage, of fielded TMD systems, particularly as the TMD systems themselves are improved. While U.S. systems constitute the majority of fielded antimissile systems today, other allies also have the potential to achieve TMD capability, especially for use with their military forces were they deployed in a crisis situation or coalition effort;

- Planned modification to PATRIOT beyond the fielded PATRIOT Advanced Capability Level-2 (PAC-2) with consultations centered on allied plans to incorporate near term improvements for PAC-2, their planning for PATRIOT Advanced Capability Level-3 (PAC-3), and effective operations with U.S. TMD forces;

- HAWK improvements and the intent of some of the nations that currently deploy improved HAWK (with FPS-117s) to upgrade their systems with the improvements planned by the U.S. Marine Corps (USMC). This would achieve an interim and point defense capability against short-range theater missile threats;

- Upgrades will be made to the AEGIS Combat System to support detection, tracking and engagement of theater ballistic missiles using the SM-2 Block IVA missile. Modifications will be made to data links to support the receipt and transmission of TBM cues to and from Joint Allied Units. There is a current Foreign Military Sales (FMS) case with Japan involving the sale of AEGIS Combat System for integration into Japan's DDG 173 Class destroyers;

- AEGIS Standard Missile Block IVA, or an indigenous missile incorporating similar TBMD capabilities. This type of missile, together with the CEC concept and an AEGIS or indigenous phased array radar system, could be incorporated into the new air defense frigates now planned by several European countries.

Another near to mid term opportunity for allied involvement is the Commanders-in-Chief's (CINC's) Assessment Program to improve current TMD command, control, and communications capabilities in the field. This program is designed to increase the understanding of TMD capabilities, to develop and refine tactics, and to implement TMD force operations as developed by the theater CINC. The CINC's TMD Experiments Program helps the CINC perform TMD missions by subsidizing the cost of including realistic TMD activity into existing and planned exercises, providing expertise to the CINC in exercise planning and communications connectivity, and bringing new ideas and capabilities to the field during exercises.

The exchange of information between the users and developers has fostered great interest among the CINCs during the past two years. Additional program goals include the fostering of interoperability with our allies and the development and refinement of TMD concepts of operations. The CINC's Assessment Program builds bridges among our allies, our joint forces and the TMD system architect, Ballistic Missile Defense Organization (BMDO). The program has substantially increased current and near to mid term TMD capabilities without the addition of a new weapons system. The presence and use of the Tactical Surveillance Demonstration (TSD) in the European Command (EUCOM), demonstration of the Cooperative Engagement Capability (CEC) concept during the Mediterranean deployment JTF-95, and use of both Tactical Surveillance Demonstration Enhancements (TSDE) and TALON SHIELD in the Korean theater exercise ORNATE IMPACT (August 1993) are prime examples of surveillance and warning enhancements and improved threat data fusion provided via this program and other similar activities.

7.3.3 Far Term Allied Strategy

The far term strategy is to build on these near to mid term achievements with the objective of further enhancing lower tier capabilities and adding the upper tier capability necessary to counter more advanced theater missiles for both (a) defense-in-depth of military forces and (b) territorial theater defense. The potential for foreign involvement in a far term program and the extent of such involvement, will depend upon where that particular program is in the acquisition process. A key determinant is when the U.S. and individual nations engage in discussions on participation in a program. Generally, the earlier that the ally becomes involved, the better the opportunity for cooperative activities. Detailed technology transfer determination will be made for each prospective program.

Discussions early in a program's development may allow for joint development and production. For example, the U.S. Corps SAM program was in the initial phases of Concept Definition (CD) and, therefore, offered an excellent opportunity for international participation. Germany, France, and Italy have comparable requirements to replace aging Improved HAWK (I-HAWK) air defense systems with a new advanced system with both air and missile defense capabilities. A multilateral development plan for such a system, to be called the Medium Extended Air Defense System (MEADS) has now been reflected in a Statement of Intent among the four nations. Allied requirements will be harmonized with U.S. requirements; responsibilities and fundamental terms and conditions will be included in the International Agreement for the initial phase.

The Theater High Altitude Area Defense (THAAD) on the other hand is a fast moving, high priority program well into the Demonstration and Validation (Dem/Val) phase and, for now, offers little opportunity for foreign involvement. While the U.S. prime contractor might be able to include limited foreign subordinate contractors for some special requirements, the schedule does not allow interruptions for negotiations or prime contract modifications. At and beyond the Engineering and Manufacturing Development (EMD) phase, the THAAD program would present opportunities for foreign participation. These opportunities can involve including foreign technologies as product improvements, elements of manufacturing risk reduction, or dual sourcing of system components or elements. Foreign participation, if it occurs even later in the program, e.g., PATRIOT, may be limited to licensed production or purchase of the system.

Initiating discussions early ensures that both sides will be able to take advantage of opportunities to reduce cost, avoid redundancies, and improve operational concepts. Such a process would not negatively impact the aggressive schedules established for the U.S. program, which is predicated on putting new, improved capabilities into the force structure as soon as possible.

7.4 Status

The United States has long pursued active programmatic and policy dialogue with European and Asia/Pacific allies, as well as with Israel, on BMD. A "core group" of allies has been involved: NATO countries, Australia, Japan, South Korea and Israel, largely working in the area of TMD technology and concept developments. The U.S. decision to emphasize TMD has tended to move our activities with allies from exclusively basic R&D more toward development and procurement programs. As discussed below, we are now exploring opportunities for cooperation with our allies consistent with our existing security relationships and guarantees. Such discussions are easier because, in many cases, there are long-standing TMD-related relationships, including much cooperative research and technology development that has occurred over the last ten years.

7.5 Selective Status of Nations and NATO

7.5.1 United Kingdom

The United States has been involved with the United Kingdom on BMD research experiments and flight trials and information exchanges since 1985 under an overarching memorandum of understanding. This has led to a strong relationship on BMD issues with the U.K. defense establishment and industry.

The British government is now proceeding on a 14-month Pre-feasibility Study to determine national BMD requirements, including TMD for protection of its military forces deployed abroad; note that the British will also command the new NATO Allied Command Europe's (ACE) Rapid Reaction Corps (ARRC). American contractors are part of the British team that is conducting the study. The U.K. requirements will necessarily include area defenses. The DoD will work closely with the U.K. Ministry of Defence to ensure that the government modalities associated with possible cooperation on, or direct sales of, U.S. TMD systems are properly reflected in their study results. In the meantime, the U.S. and the U.K. are exploring cooperative technology demonstration programs that would have particular applicability to their national and alliance programs.

7.5.2 Germany

Germany's involvement in antimissile programs began with its implementation of the U.S.-German Roland PATRIOT Agreement in 1984. Germany was to provide funds in support of specific antimissile programs and thereby contribute to defense improvement of U.S. airfields in Germany; German funds and technology were used in the design and demonstration of an adjunct seeker for use on the PATRIOT missile--the multimode seeker. In addition to being a partner in the quadrilateral MEADS development, Germany is currently working closely with the U.S. to develop a fully interoperable capability between PATRIOT systems. Germany is also a key partner in the weapon lethality area.

7.5.3 Israel

Israel has been involved in U.S. missile defense programs since 1987. Related activities have included architecture studies, participation in several technology experiments, examination of boost phase intercept concepts, and the development of its indigenous interceptor, Arrow. Israel was the first nation to declare its intent to field national missile defense systems to counter the proliferated missile threat of Scud and Al Hussein missiles. Israel and the United States have a joint program to develop the Arrow interceptor. Israel has funded its share of the Arrow development, as agreed by the governments, and is also committing resources, to develop the fire control system, surveillance, and battle management systems needed to make Arrow an operational system.

In response to Congressional interest, BMDO is negotiating an agreement with the Israeli Ministry of Defense (IMOD) to continue involvement in the development of the Arrow Weapons System, called the Arrow Deployability Project (ADP). This project will focus on integration centered around three system tests of the jointly developed Arrow interceptor with the indigenously developed fire control radar, launch control center, and battle management center. The project will also address issues of interoperability between Israeli and U.S. TMD systems.

In FY 1995 the BMDO and the IMOD continue the study effort begun in FY 1994 on the boost phase intercept concept. The focus of the FY 1995 study is to examine the Israeli concept developed in FY 1994 and to use simulations and analysis to determine if areas of compatibility exist between U.S., Israel and coalition force requirements.

7.5.4 Japan

The growing North Korean ballistic missile program (centered on the No Dong and Taepo-Dong missiles) has heightened Japanese government and public concern. The United States-Japan TMD Working Group, brought together to discuss possible future Japanese involvement, has in turn chartered a bilateral study on Ballistic Missile Defense (BMD). This Japanese-led BMD study, currently scheduled to be completed in 1996, will examine possible options for defense of Japan against the regional missile threat.

Japan is in the process of procuring/upgrading those systems which would provide a potential infrastructure upon which a TMD capability could be established. Japan has been producing, under license to Raytheon, the PATRIOT PAC-1 missile system since 1985. In late 1994, Japan commenced licensed production of the upgraded version of PATRIOT, i.e., PAC-2, to be deployed

operationally beginning in 1995. The Japanese Maritime Self Defense Force will receive the second of four programmed AEGIS-class destroyers in mid-1995. Boeing Aircraft Corporation is currently producing the first two of what will be a total Japanese Foreign Military Sales (FMS) buy of four E-767 Airborne Warning And Control System (AWACS) aircraft. Such systems provide a strong infrastructure upon which Japan could build a TMD capability in the future.

7.5.5 France

The recently published French "White Paper", their first in 22 years, recognizes the myriad geopolitical changes, and, as a result, France should no longer rely exclusively on their independent deterrent as the basis of their security. Among the emerging new requirements for the French military capabilities is ballistic missile defense. Accordingly, the French have embarked on an aggressive five year BMD technology development program, to be accomplished indigenously and cooperatively. In addition to also being a partner in the MEADS development, France is also studying the possibility of developing an upper tier TMD system. In addition, France has an interest in developing space based surveillance and early warning capability for the European region.

7.5.6 NATO

Discussions with NATO continue on the problems of proliferation, emerging defense requirements and program information in meetings of NATO Defense Ministers and meetings regarding the improvement of TMD. As part of its on-going work, NATO's Senior Defense Group (DGP) on Proliferation completed in December 1994 its Risk Assessment of the proliferation threat. The group concluded, inter alia, that preventing the proliferation of Weapons of Mass Destruction (WMD) and their missile delivery systems remains NATO's top proliferation priority. Also, they concluded that such efforts are not likely to fully stop missile proliferation and, accordingly, NATO should begin to prepare a range of military capabilities to discourage proliferation including missile defenses to further protect forces and populations. In concert with this direction from the political level, Supreme Headquarters Allied Powers Europe (SHAPE) has now concluded a draft Military Operational Requirement that delineates the need and how to respond to the risks posed by potential enemies using ballistic missiles against NATO targets.

The NATO Conference of National Armaments Directors (CNAD) established an Extended Air Defense/Theater Defense Ad Hoc Working Group (EAD/TD AHWG) composed of interested nations with resources to contribute to TMD. The AHWG's charter is to define future opportunities and methods of collaboration in the area of TMD. The nations participating in the AHWG are the United States (Chair), Canada, France, Germany, Italy, Norway, the Netherlands, and the United Kingdom.

Topics under discussion include the improvement of early warning, BM/C^3, lethality, infrared plume phenomenology, HAWK upgrades, modelling/simulation and exercises, and upgrades to existing air defense systems such as putting an infrared search and track sensor on AWACS aircraft. Some of the far term areas of cooperation to be discussed include maritime TMD, and area defense interceptors. The Group submitted its final report to the CNAD in April 1995. The report discussed detailed plans ("Road Maps") for sensors, BM/C^3 and interceptors which NATO and NATO nations should follow to achieve an integrated, interoperable TMD capability in the long term. A significant number of specific projects are identified for the countries to begin the process of achieving the long-term capability.

7.5.7 The Netherlands

The Dutch have been particularly active participants in the NATO Ad Hoc Working Group efforts. They are studying their requirements with a view toward possible purchase of PAC-3 for their operational PATRIOT Systems. Furthermore, they have expressed strong interest in the Navy's planned Standard Missile-2 Block IVA developments and so-called Cooperative Engagement Concepts for inclusion in the capabilities for their next generation air defense frigate, to become operational around the turn of the century.

7.5.8 Australia

At the March 1994 U.S.-Australian Ministerial talks in Canberra, both governments expressed a desire to identify areas in the U.S. BMD program for mutual cooperation, in order to prevent proliferation of ballistic missiles. The December 1994 Australian Defence White Paper echoed the sense of the March Ministerial talks. Discussions on cooperation are ongoing.

7.5.9 Russia

BMDO is also involved in a number of technology cooperation projects with Russia. Several programs and experiments are underway. Skipper is a joint experiment planned for June 1995 to evaluate aerobraking and aerothermal chemistry in the upper atmosphere. The joint Active Geophysical Rocket Experiment (AGRE) program will investigate the effects of an explosive plasma jet on the ionosphere and evaluate vehicle environmental interactions. There are also several other small scale basic and applied research programs with Russia currently being sponsored by BMDO.

7.8 Foreign Contribution

Section 242 of the 1994 National Defense Authorization Act enabled the establishment of a special account in the Treasury that would be able to accept any contribution of money from any nation or any international organization for use by the Department in support of TMD programs. The potential for contributions to this account does exist, but none has been realized to date. This element of potential foreign support or contribution to the U.S. TMD program is being discussed with nations and their participation may include such contributions in the future in accordance with their budget approval process.

7.9 Summary

The need for missile defense in the face of the proliferation of ballistic missiles and weapons of mass destruction is recognized by the international community and governments are now taking steps to resolve their defense deficiencies with regard to the threat. DoD has established a sound plan to enable evolutionary improvement of national capabilities and is fully engaged in international discussions on the merits of collaborative programs. Significant international participation in the program will insure that our goal of improved missile defense systems at reduced cost, while avoiding redundancy and improving interoperability, can be achieved.

Chapter 8

Ballistic Missile Defense Countermeasures

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Ballistic Missile Defense Countermeasures

8.1 Introduction

Potential countermeasures to ballistic missile defense has been a critical consideration in developing ballistic missile defense strategy since the early days of the Strategic Defense Initiative (SDI) program. Public Law 99-145, Section 222 (dated November 8, 1985) states "A strategic defense system development, test, and evaluation conducted on the Strategic Defense Initiative Program may not be deployed in whole or in part unless- (1) the President determines and certifies to Congress in writing that- (A) the system is survivable (that is, the system is able to maintain a sufficient degree of effectiveness to fulfill its mission, even in the face of determined attacks against it)" and "(B) the system is cost effective at the margin to the extent that the system is able to maintain its effectiveness against the offense at less cost than it would take to develop offensive countermeasures and proliferate ballistic missiles necessary to overcome it;...". To address these concerns, the Ballistic Missile Defense (BMD) program aggressively analyzes, develops, and tests potential system countermeasures and develops passive and active survivability technologies, methods and tactics.

As the BMD program focus changed to developing and fielding theater missile defense systems and developing national missile defense technologies, efforts in countermeasures continued with an appropriate change in emphasis.

8.2 Theater Missile Defense

Since 1991, the BMD countermeasures program has concentrated on analyzing the potential countermeasures available to Rest-of-World (ROW) countries and the effect of these countermeasures on Theater Missile Defense (TMD) systems. Ballistic Missile Defense Organization (BMDO) completed three extensive analyses (Red-Blue Exchanges) of the effect of potential ROW countermeasures on TMD systems. These Red-Blue Exchanges rigorously investigated possible susceptibilities in TMD systems and identified and analyzed potential countermeasures. The Red-Blue Exchanges analyzed the impact of countermeasures upon the effectiveness of Theater High Altitude Area Defense (THAAD), Ground Based Radar (GBR), PATRIOT, Extended Range Intercept Technology (ERINT), Corps SAM, AEGIS SM-2 Block IVA, and Arrow. These analyses resulted in a wide variety of technical and operational actions which could be used by TMD system developers and operators to mitigate the effects of countermeasures.

The BMD countermeasures program began working with TMD system acquisition offices to determine the range of effectiveness of potential countermeasures and counter-countermeasure techniques. The first such Counter-Countermeasure Parametric Study was conducted with the GBR project office and is scheduled to be completed in 1995.

BMDO completed detailed threat designs of potential TMD countermeasures to ascertain the difficulty in fielding the countermeasure as well as the potential effectiveness of the countermeasure. BMDO continued to conduct high fidelity simulations of countermeasures and counter-countermeasure responses in Government test beds and simulation facilities, such as the National Test

Bed (NTB) and Optical Discrimination Algorithm Development Center.

BMDO developed and implemented an innovative way of assessing the difficulty for a ROW-like country to develop, build, and deploy countermeasures. This project uses a small team of junior engineers to design, fabricate, assemble, and ground or flight test TMD countermeasures in a simulated ROW environment. The BMDO threat and acquisition communities use the difficulty and effectiveness information from these efforts to help determine the appropriate course of action for dealing with countermeasures.

In summary, BMDO has diligently investigated the technical feasibility and difficulty of ROW countermeasures and their effect upon TMD system performance. This information is shared with the TMD system developers and intelligence community to prevent surprises and prepare for possible indicators of ROW countermeasures development. This countermeasures work supports system trade studies and analyses to provide counter-countermeasure for TMD systems. BMDO will continue countermeasures studies and testing to ensure that deployed TMD systems will be robust and meet their operational requirements on a battlefield that includes adversary countermeasures.

8.3 National Missile Defense (NMD)

BMDO completed a Red-Blue Exchange on the NMD First Site System in FY 1994. The Red Team analyzed the susceptibility of the NMD system and devised technologically feasible countermeasures from potential adversaries. The Blue Team developed innovative technical and operational counter-countermeasures to restore performance degradation from the countermeasures during this study. The information from this Red-Blue Exchange will be used to support the NMD Technology Readiness Program. The results will be updated in 1995 and documented in an NMD Countermeasures Assessment Report.

Appendix A

Current Program, Projects, And Activities - Narrative Description And Status

PROJECT NUMBER: 1151
PROJECT TITLE: Sensors (Active and Passive)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	107,142	102,675	88,920

PROJECT DESCRIPTION:

This project develops the active and passive sensor technologies required for National Missile Defense (NMD). The project includes development of technologies required for the NMD Radar Technology Demonstrator (RTD), the Midcourse Space Experiment (MSX) satellite program, the Active Geophysical Rocket Experiment (AGRE), Red Tigress, Space Test Research Vehicle-2 (STRV-2), and the development of passive sensor component technologies. Each of these programs is discussed below:

- NMD Radar Technology Demonstrator (NMD-RTD) -

As a primary fire control sensor for the NMD system, the radar performs surveillance, acquisition, track, discrimination, fire control support, and kill assessment. To support precommit, the radar will plan and schedule its sensor resources to search autonomously or in response to a cueing hand over. The NMD-RTD will acquire, track, classify/identify and estimate object trajectory parameters. In post-commit, the radar schedules its sensor resources to continue tracking the target to provide an In-Fight Target Update (IFTU), and a Target Object Map (TOM) to the assigned interceptor. The NMD-RTD provides a low cost, capable sensor to fully test and validate the integrated operation of all prototype elements in a NMD system for hit-to-kill operation. Resolution of the critical radar issues will reduce design, fabrication, and test time associated with deploying an NMD-GBR in Continental United States (CONUS). Resolution of system integration issues will also substantially reduce deployment lead time and risk for the NMD system.

The NMD-RTD is an incremental program that leverages from developments under the Theater Missile Defense-Ground Based Radar (TMD-GBR) program to resolve the radar critical issues applicable to NMD. These critical issues are discrimination, Target Object Map (TOM), kill assessment, and electromechanical scan. The program includes algorithm development, real-time software and Hardware-In-The-Loop (HWIL) simulations, and radar validation testing with other NMD elements. The alignment of the NMD-RTD program with the TMD-GBR Demonstration and Validation (Dem/Val) program and the Exoatmospheric Kill Vehicle (EKV) flight tests has reduced overall program costs. However, the realigned schedule has increased the fiscal demands in FY 1996 in excess of the original NMD-RTD plan. The NMD-RTD will leverage from the TMD-GBR Transmit/Receive production line further reducing costs. FY 1996 activities concentrate on continuation of algorithm development, system analysis and design, and software and hardware simulation development activities begun in FY 1995. FY 1997 activities concentrate on completing design activities, validating software builds, and fabrication of the antenna subsystems. In FY 1998, the NMD-RTD will convert existing TMD-GBR Dem/Val hardware into a larger, limited field-of-view unit with sufficient range to support NMD test requirements beginning in FY 1999.

- Midcourse Space Experiment (MSX) -

MSX will provide data on real midcourse targets against real backgrounds at realistic ranges for use in system ground demonstrations; demonstrate key functions such as acquisition, tracking, handoff and bulk filtering; provide multiwavelength target phenomenology data for assessing optical discrimination algorithms; and demonstrate the capability to integrate key technologies into a working platform similar to proposed operational midcourse sensor designs. MSX will provide target signature data, statistically significant background data, functional demonstrations with post test analysis, and technology demonstrations necessary to support achieving exit criteria for milestone decisions for a space based tracking sensor and other infrared sensor/seeker systems. MSX will launch in 1995, and will perform a variety of experiments, including target observations, background observations, and surveillance demonstrations, during its five year life (18 month cryogen IR). MSX will observe one dedicated target mission, five sounding rockets (NMD/TMD combined experiments), and three cooperative AGRE launches. MSX data will flow to the users throughout the five year life of the program.

The MSX Targets program provides dedicated and cooperative targets for MSX orbital tests and for TMD/NMD joint experiments. These targets will be used to test the limits of a passive sensor to detect, track, and characterize both strategic and tactical threat ballistic missiles.

- Active Geophysical Rocket Experiment (AGRE) -

AGRE is a new start, joint project involving both the Johns Hopkins University Applied Physics Laboratory (JHU/APL) and the Russian Academy of Sciences Institute for the Dynamics of Geospheres (IDG). The program has two objectives: first, to perturb and observe the effect on the nighttime atmosphere and ionosphere at 500 km by an impulsive high-speed plasma jet; and second, to provide realistic national missile defense-type targets for observation by Ballistic Missile Defense Organization's (BMDO's) Midcourse Space Experiment (MSX) satellite. The AGRE program will provide three large vehicle launches for observation by MSX satellite. The four diagnostic payloads carried into orbit with the IDG's plasma jet generator will monitor the signatures of the atmospheric/ ionospheric disturbance. Three of the payloads will be instrumented by IDG and one by JHU/APL. The MSX data will be analyzed and delivered to the Air Force's space based tracking sensor program. The JHU/APL and Russian data analysis reports will also be submitted to the space based tracking sensor program.

- Red Tigress -

This program continues the data analysis and distribution from the Red Tigress II mission and develops and validates infrared and radar discrimination algorithms. The data analysis being performed is on the telemetry data collected by the sensors on board the Red Tigress II craft. The next launch is planned for FY 1996.

- Passive Sensor Component Technology -

A set of research and development efforts is being conducted for critical sensor components in

support of over the horizon long wave infrared tracking and discrimination functions for midterm and objective NMD system. The projects in optics, electronics, Focal Plane Arrays (FPAs), long lifetime cryogenic coolers, and signal and data processing will develop state-of-the-art technologies for a space based tracking sensor and EKV elements. The NMD architecture requires passive sensor components to operate in the space environment and view targets against the earth limb and space background. In particular, the high radiation levels and large temperature swings in space stress the ability of sensor components to perform to their requirements. The background noise of space is low, and FPAs are being developed with low noise to take advantage of this. The FPAs developed under this project are different from those developed under Project 1161-Advanced Sensor Technology, Project 1267-Ground Based Interceptor, and Project 1651-Innovative Science and Technology. Projects 1161 and 1651 are developing very advanced FPAs which are not mature enough to fit into the development schedule of the objective space based tracking sensor system. Project 1267 is developing FPAs for interceptor environments (for the EKV), which have a higher background noise, and do not meet the low noise requirement for a space based tracking sensor. Signal and data processors, and associated memories, will be developed in order to meet the high performance and reliability requirements in the harsh space environment. Cryocoolers are evaluated for vibration, cooling capability, life expectancy, reliability, and failure mechanisms. Focal plane arrays are tested for response, uniformity of response, harsh environment operation and recovery, dissipated heat, thermal response, and pixel operability. Optical components are evaluated for radiation and shock response, and optical performance. Contamination control devices are evaluated for keeping optical components clean from matter that degrades mirror and filter performance. Electronics components are tested for reliability, speed, and performance to determine any degradation from temperature and radiation effects. Certain commercial-off-the-shelf components are tested to determine whether they meet a space based midcourse tracking sensor's requirements, thereby eliminating development costs of these components.

- Space Test Research Vehicle-2 (STRV-2) -

STRV-2 is a BMDO multinational (U.S. and U.K.)/multiagency (AF, NASA, and OSD) funded flight demonstration program in a similar orbital environment to the space based tracking satellites. A U.K. developed Medium Wavelength Infrared (MWIR) system will obtain background/clutter data using filters supplied by the SMTS (BE) program office; a one year mission duration and elliptical orbit (400-1,800 km) will provide seasonal and altitude variations. Contamination, radiation damage to a space based midcourse tracking sensor focal plane array and microelectronics, advanced vibration isolation/suppression techniques, micrometeoroite and debris monitors, space environment effects on advanced materials, and the performance of a high bandwidth laser communications system will be evaluated. This program is in design hardware manufacturing and currently a candidate for Space Test Experimental Program (STEP) Mission 5.

PROJECT NUMBER: 1155
PROJECT TITLE: Phenomenology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	6,566	0	0

0603871C RDT&E	31,028	14,672	17,593
0603872C RDT&E	40,348	44,011	52,777

PROJECT DESCRIPTION:
The Phenomenology program supports both the Theater Missile Defense (TMD) and National Missile Defense (NMD) programs as well as BMDO's advanced technology programs for ballistic missile defense.

Activities in support of NMD include collection of radar and optical data on missile targets and intercept events for NMD-RTD and Ground Based Interceptor (GBI) discrimination and kill assessment algorithm development; application of background data (Midcourse Space Experiment (MSX) and Miniature Sensor Technology Integration (MSTI)) to GBI and SMTS to (a) evaluate algorithms which allow detection, tracking, and discrimination of strategic incoming targets from background clutter, and (b) upgrade background and target models and codes; development of specific phenomenology signature models and integrated tools such as the Synthetic Scene Generation Model (SSGM) for a realistic evaluation of surveillance, acquisition, tracking, and discrimination techniques; developing and evaluating discrimination and kill assessment algorithms (the Lexington Discrimination System (LDS) is used to evaluate discrimination performance and serve as a test bed for development of discrimination architectures); and storage, archiving and retrieval of data in the BMDO-funded Background, Plume, and Missile Defense data centers.

In support of TMD this project funds the operating costs of the Cobra Judy radar platform and the core operating costs of the Advanced Sensor Technology (AST) optical data collection platform. The mission signature requirements are provided either directly by various projects or through the Target Signature Working Group (TSWG). This project manages the facilities (data centers) that are needed to store and make available the critical data to the TMD user community. This project provides for radar and optical algorithm and model development to aid in the rapid distinction of incoming missile targets from natural and clutter backgrounds and/or penaids. In addition, this TMD effort includes the collection of radar and optical data on TMD missile targets and intercept events to satisfy the needs and requirements levied through the TSWG (Project 1170) and by the various project offices, and discrimination algorithms that are specific to TMD applications are developed and evaluated. The Lexington Discrimination System (LDS) is used to evaluate discrimination algorithm performance and serve as a test bed for development of discrimination architectures. Storage, archiving and retrieval of data takes place in the BMDO-funded Background, Plume, and Missile Defense data centers.

In addition, this project supports a selected set of international technical exchange programs in the areas of optical and radar discrimination, reentry, background, and plume phenomenology. The basic approach involves identifying areas where mutual benefits can be realized through joint activities such as joint participation in ground and flight tests, phenomenology code/algorithm comparisons, data exchanges, and joint data analyses. Technically, the U.S. stands to gain from insight into foreign code capabilities (identifying areas not handled well by U.S. codes), access to a broader range of data sets and test opportunities, and access to areas of unique foreign expertise (e.g., U.K. penaid design). From a technology and funding perspective, there is potential U.S. gain from foreign contributions to flight tests, experimental hardware, and data collections.

This project supports the team of U.S. experts in the areas of discrimination, reentry signatures, backgrounds, and plumes that is necessary to assess proposals for joint efforts and ensure that interchanges result in benefits to U.S. programs. This team proposes, plans, and executes joint data collections, data analyses, and code and algorithm comparisons. Current U.S. background, target signature, and plume technology bases include a wealth of data and a number of codes and models which have been systematically built up over the past few years. There is considerable international interest in this technology. These international efforts provide the means to advance the backgrounds and plume technology bases and leverage foreign cooperative programs.

Current programs include: U.S./U.K. Scientific Cooperative Research Exchange (SCORE) Program - Target Signatures & Backgrounds (TSB) Panel; NATO Extended Air Defense (EAD)/ TMD Ad Hoc Working Group (AHWG) - Plume Phenomenology Expert Group (U.S., U.K., France, Canada); U.S./French Bilateral Group - Plumes, Backgrounds, and Reentry Signatures; U.S./Israeli TBM Signature and Phenomenology Research; U.S./German Phenomenology Research.

PROJECT NUMBER: 1161
PROJECT TITLE: Advanced Sensor Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	10,162	23,500	27,840
0603872C RDT&E	2,739	3,782	3,800

PROJECT DESCRIPTION:
This project develops advanced technologies in support of National Missile Defense (NMD) and Theater Missile Defense (TMD) systems needed for post-2003 missile defense and the survivability technologies required for ballistic missile defenses. This project includes the Advanced Sensor Technology Program (ASTP), the Russian American Observation Satellites (RAMOS), and survivability technology development.

The Advanced Sensor Technology Program (ASTP) will develop and demonstrate enhanced performance sensor subsystems that are needed for post 2000 missile defense. Previous advanced development efforts (like those formerly in Project 1201 Interceptor Component Technology) were focused only on component development and were managed separately. In FY 1994 plans were made to consolidate these advanced sensor technology efforts into a single program to leverage funding and more efficiently develop sensor subsystems applicable to a variety of missions, including atmospheric surveillance and interceptor seekers beginning in FY 1995. For the surveillance application, emphasis is placed on timely detection of missile launches from long ranges, precise tracking for launch site location and impact/ intercept point prediction, target designation, and kill assessment. Development of Long Wavelength Infrared (LWIR) passive sensors, miniaturized LADARs, and radar components necessary to achieve long-range threat detection, accurate homing guidance, and aim point selection for autonomous hit-to-kill interceptors will be performed in the Advanced Interceptor and Systems Technology (AIST) program in Project 1270-Applied Interceptor Materials and Systems Technology. The AIST program will build upon achievements made in sensors and sensor data fusion as a part of the ASTP program.

Specifically, these demonstrated subsystems support upgrades to the surveillance and tracking sensor elements of NMD (Projects 1151 and 1267), and future TMD system generation.

Advanced sensor subsystems for NMD and TMD surveillance systems under development in FY 1995 have been selected based on their capabilities to address future ballistic missile threats with increased sophistication. Specifically, ASTP will develop passive and active sensors for long-range threat detection and for target tracking and identification. Passive infrared, radar, and LADAR components will be improved to deliver increased performance while decreasing sensor size, mass, and power consumption. Active and passive sensors will be integrated into a compact assembly to enable surveillance from distributed platforms, either in space or in the atmosphere (via aircraft). Real-time sensor data fusion techniques and processing hardware will be developed and combined with the integrated sensor package. This will provide a fused sensor system capable of precise threat identification with a more rapid response by exploiting multiple phenomena, thereby increasing the probability of detection and correct target identification, extending the defended area, improving probability of kill, and reducing the probability of leakage.

The Russian American Observation Satellites (RAMOS) program is an ongoing cooperative effort with Russian scientists and engineers for stereo collection of infrared background phenomenology and target signatures. The program leverages existing funded experiments to develop 3-dimensional background and target characterizations to support phenomenology needs of TMD and NMD systems, including the Space Based Infrared System (SBIRS). This cooperative program averts the loss of this expertise to Third World countries and fosters a closer working relationship at the technology level between both nations.

The survivability program develops technologies for both NMD and TMD. The NMD focus is to develop and demonstrate survivability technologies to ensure that strategic ballistic missile defense elements can perform their mission in adverse environments and in the face of expected hostile threats. Approaches include: studies/analyses; defense suppression threat mitigation technologies development; survivability/operability demonstrations; and hardened technology integration. Specifically, the effect of low-power laser illumination on space based Medium Wavelength Infrared (MWIR) and Short Wavelength Infrared (SWIR) sensors will be evaluated. Technologies will be available for incorporation into NMD elements at Engineering and Manufacturing Development (EMD) and will also provide near term improvements to existing systems. Demonstrations will provide necessary risk reduction evidence to support milestone decisions. This program was not funded in FY 1995 due to limited NMD funding.

In support of TMD, this program develops and demonstrates survivability technologies to insure that ballistic missile defense systems can perform their mission in all required environments. Ballistic missile defenses must be able to operate in disturbed environments and against countermeasure rich threats. The requirements for this survivability program are: define, develop and demonstrate survivability enhancement options for theater missile defense elements; develop and transfer Survivability Enhancement Options (SEO) technology base to research and development centers and laboratories; provide risk reductions to support THAAD/TMD-GBR Milestones II.

In addition, this program develops and demonstrates survivability technologies to ensure that TMD systems can perform their mission in all expected hostile threats. Approaches include: studies/analyses; defense suppression threat mitigation technologies development; developing

enhanced shelters applying Camouflage, Concealment and Deception (CCD), SEO development; Electromagnetic Environmental Effects (E^3) engineering support, survivability/operability demonstrations, development of issue resolution approaches, development of Anti-radiation Missile (ARM) Countermeasure Evaluator (ACE), and hardened technology integration. Technologies will be available for incorporation into missile defense systems at EMD and will also provide near term improvements to existing systems. Demonstrations will provide necessary risk reduction evidence to support THAAD system milestone decisions.

PROJECT NUMBER: 1170
PROJECT TITLE: TMD Risk Reduction
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603872C RDT&E	25,550	46,458	40,000

PROJECT DESCRIPTION:
This project is the primary Ballistic Missile Defense Organization (BMDO) risk mitigation program addressing Theater Missile Defense (TMD) target/threat signature (and the signature-to-system interface) issues for all TMD systems. This project consists of four programs: TMD Critical Measurements Program (TCMP) which builds, flies, observes, and analyzes targets with characteristics similar to those anticipated on foreign threats; the Target Signature Measurements Program which observes and directs the analysis of signatures from BMDO test targets (Storm, Hera, etc.) to obtain target signature truth data, and which exploits other similar threat signature opportunities; the Focal Plane Array Flight Test Program which flies an airborne sensor package carrying a Theater High Altitude Area Defense (THAAD) type focal plane array to directly observe BMDO interceptor targets to obtain representative seeker data; and the Kill Assessment Program which investigates target intercept phenomenology. In all cases, the target signature truth data and the analyses address the specific areas of discrimination, target object map hand over, aim point selection, and kill assessment. The core sensor costs used in this project to collect target signature and truth data will be provided under projects 1155 and 3360. This project will be used to fund the specific sensor tasks for each mission.

- TMD Critical Measurements Program -

This program supports the risk mitigation efforts in TMD signatures. TMD Critical Measurements Program (TCMP) is a flight test program where threat representative targets are flown at the Kwajalein Missile Range (KMR) in order to observe typical threat-like objects in flight with a sophisticated suite of sensors. These sensors give both target truth data and representative signature data as seen by TMD system sensors. The TCMP program performs the analysis on the data obtained in these flights. In all cases, the target and threat truth data and the analysis address the specific areas of discrimination, target object map hand over, aim point selection, and kill assessment. The hardware, flight instrumentation and analysis of the TCMP flights are all included in the TCMP budget. TCMP-2 will consist of four flights in the third quarter of FY 1996.

- Target Signature Measurements Program -

This program funds the mission costs to acquire truth data using sophisticated sensor platforms (Airborne Surveillance Testbed (AST), HALO, Sealite Beam Director (SLBD), etc.) on BMDO interceptor target flights (LANCE, Storm, Hera, etc.). These data are then utilized by the acquisition programs, by the Target Signatures Working Group (TSWG), and by the Targets Program to establish the in-flight signature characteristics of these targets for use in target hardware development and interceptor algorithm assessment.

- Focal Plane Array Flight Tests Program -

This program will provide for the integration, testing, calibration, and mission support of an airborne optical IR sensor using a Focal Plane Array (FPA) similar to the THAAD seeker. The sensor fabrication is complete and will be placed on the High Altitude Observatory (HALO) aircraft to assist in assessing the Platinum Silicide (PtSi) FPA performance against TMD-like targets. The sensor will take optical measurements on various TMD tests to include the THAAD Demonstration and Validation (Dem/Val). The sensor data will support seeker algorithm and modeling development efforts leading to a more robust system performance capability. This program also supports performance enhancements and survivability issues of the PtSi FPA in direct support of the THAAD seeker.

- Kill Assessment Program -

This program is developing the technical basis which will lead to a battle management decision capability for the TMD architecture. This capability will enable the battle manager to respond operationally in "real-time" following a target intercept engagement to either proceed with a cease fire or to order a second shot and or to cue the lower tier for appropriate action. This kill assessment capability will also help measure defense system effectiveness and to identify threat warhead type. In support of this shoot-look-shoot doctrine, the program is conducting a series of specialized sensor data collections of TMD interceptor tests, the follow-on data analysis, and algorithm development. The most challenging aspect is gathering enough pertinent data from various types of intercept scenes to identify and evaluate those observable characteristics that will correctly serve this decision process. Since opportunities to observe actual TMD missile intercepts are rare, more emphasis in this two year old program is being made on ground test measurements.

PROJECT NUMBER: 1265
PROJECT TITLE: Boost Phase Interceptor
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	**FY 1996**	**FY 1997**
0603870C RDT&E	40,000	49,061	44,300

PROJECT DESCRIPTION:
The Boost Phase Interceptor (BPI) Technology Program is designed to meet critical future active defense needs. The BPI program is developing new technologies to demonstrate a deterrent and counter in Theater Missile Defense (TMD) by intercepting a Theater Ballistic Missile (TBM) in

its boost phase of flight. Present TMD architectures focus on midcourse and terminal defenses which allow fragments of the TBM and or warheads to inflict potential damage on friendly areas. During a TBM's boost phase, the missile is readily visible, slow moving, and extremely vulnerable. Boost phase intercept of TBMs can cause missile debris to fall on enemy territory or to fall short of the intended target(s) and significantly reduce the number of TBMs in post boost flight, thus thinning out the number of TBMs reaching subsequent defensive layers and reducing the burden on terminal defenses. Interceptor component technologies advanced through the BPI program have potential applicability and benefit to all endoatmospheric interceptors.

The BPI program will integrate and demonstrate critical technologies culiminating in BPI technology experiments. BPI experimental elements may include off board sensor(s) that detect and track TBMs, launch aircraft, Battle Management/Command, Control and Communications (BM/C^3), the missile, and lightweight endoatmospheric Kinetic Kill Vehicles (KKVs). To achieve boost phase intercept, the interceptor missile and KKV may achieve hypersonic velocities within the atmosphere. The demonstrations will validate the solution to critical KKV technology associated with high-speed atmospheric flight and will provide (1) new capabilities with reduced costs/risks compared to current interceptor weapons systems, and enhancements to other interceptors under development, (2) reduction of technical risks and costs to support an acquisition program, and (3) technical solution to provide contingent residual boost phase intercept capabilities for theater defense. The program also will use existing contracts and technologies currently under development to reduce schedule and cost, and will be planned and conducted with BMDO, Air Force, Navy, and Army elements to maximize user interaction.

PROJECT NUMBER: 1266
PROJECT TITLE: Sea Based Theater-wide Defense (Upper Tier)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	**FY 1996**	**FY 1997**
0603868C RDT&E	68,450	30,442	33,400

PROJECT DESCRIPTION:
The Navy Theater-wide Theater Ballistic Missile Defense (TBMD) program will provide an upper tier, sea based capability to counter the TBM threat. This program will build on the core sea based program, the Lightweight Exoatmospheric Projectile (LEAP) technology efforts, and the existing AEGIS ships infrastructure. The current effort includes LEAP flight tests, an independent cost and operational effectiveness analysis, and force investigation studies including concept engineering. The program will also investigate the option of using a Theater High Altitude Area Defense (THAAD) missile variant. This project evolved from project 1216 in the FY 1995 President's Budget.

Navy Theater-wide TBMD is a candidate to begin the Demonstration and Validation (Dem/Val) Phase in FY 1998 as one of the Advanced Capabilities (ACAP).

PROJECT NUMBER: 1267
PROJECT TITLE: Ground Based Interceptor
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	137,810	126,646	149,550

PROJECT DESCRIPTION:
The Ground Based Interceptor (GBI) project, structured as a technology readiness program, will continue to develop the required Exoatmospheric Kill Vehicle (EKV) such that a capable missile defense system could be deployed if and when required. Specifically, an EKV will be developed and flight tested for the National Missile Defense (NMD) interceptor system which can accomplish intercepts of high-speed, long-range Intercontinental Ballistic Missile (ICBM) and Submarine Launched Ballistic Missile (SLBM) reentry vehicles (RVs) in the midcourse of their trajectories. Since exoatmospheric intercept is the key to an effective NMD system, the project will develop an interceptor capable of acquiring a threat cluster from information supplied by midcourse sensors, selecting the RV, and destroying it by force of impact (kinetically). The interceptor must be capable of combining NMD sensor information with the scene its on board seeker observes and selecting the lethal object for its target. If insufficient information is available from the rest of the NMD system, the interceptor must also be able to determine the lethal object through on board discrimination and target selection.

To preserve a near term contingency deployment capability, the initial focus of GBI development will be the front end of the missile, the EKV. Development of a booster and the associated launch control equipment will be deferred until after FY 2000. Thus near term resources will be concentrated on the EKV, the most critical and most technically challenging part of the interceptor. In the interim, kill vehicle flight tests will be flown on board the Payload Launch Vehicle (PLV), a booster made up of the Minuteman II second and third stages.

The GBI project also includes risk reduction interceptor technology, targets for flight testing, and the necessary range support and facilities to conduct essential intercept flight testing. GBI risk reduction technology efforts provide alternatives for the baseline interceptor program. These technology efforts focus on critical components such as on board seekers, hardened focal planes, light weight communications components, optical baffles, and flexseal booster nozzles. These items have payoff potential for improved military utility/capability. The time line for technology infusion is post FY 1999, depending on the results of EKV testing. GBI test plans include cold chamber sensor measurements, simulations, Hardware-In-The-Loop (HWIL), and flight testing. The computer simulations and ground testing will make maximum use of data gathered in other Ballistic Missile Defense Organization (BMDO) interceptor, sensor, and phenomenology programs.

The EKV sensor flight tests in FY 1997 will mitigate EKV risk by demonstrating two things which cannot be duplicated on the ground: seeker operation in the tactical environment and target selection algorithm performance against realistic (vice electronically simulated) targets. The EKV intercept flights will incrementally demonstrate NMD system capability, beginning with a limited BM/C^3 operating on line. The first test is scheduled in FY 1998. By FY 2000, the flight tests will demonstrate NMD interoperability between the EKV, in line BM/C^3, NMD Radar Technology Demonstrator (RTD) and on-line medium wavelength infrared (MWIR) Space and Missile

Tracking System (SMTS). Flight testing will prove the GBI's ability to intercept representative targets under real engagement conditions, reliably and repeatedly. The interceptor must also be able to determine the lethal object through on board discrimination and target selection.

PROJECT NUMBER: 1270
PROJECT TITLE: Advanced Interceptor Materials and Systems Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	15,415	21,731	25,660

PROJECT DESCRIPTION:
The Advanced Interceptor and Systems Technology (AIST) program develops and demonstrates: interceptor sensor processing power components; multifunctional material and structures; low cost interceptor component composite manufacturing processes; gel propellants and low cost flight test demonstrations. These advanced technologies are critical to the deployment of effective, affordable Theater Missile Defense (TMD) and National Missile Defense (NMD) systems. The AIST program consists of the following major task programs:

- Advanced Interceptor Components Program -

The focus of the Advanced Interceptor Component program is the development of interceptor components necessary to achieve long-range threat detection, accurate homing guidance, discrimination, and aim point selection for autonomous hit-to-kill interceptors.

- The Materials and Structures (M&S) Program -

The M&S program develops advanced low cost manufacturable multifunctional composite structural components, sensor jitter adaptive and passive vibration isolation and suppression systems, optical materials and baffle specialty components, and low temperature superconductor Long Wavelength Infrared (LWIR) sensor electronics.

- Power Technology Program -

The Power Technology Program provides test data from Russian TOPAZ II space nuclear reactors and develops power components for interceptors. The TOPAZ program is scheduled to be transferred to the Defense Nuclear Agency for FY 1996. The remaining funding will be used to develop power component technology providing weight and performance improvements.

PROJECT NUMBER: 1360
PROJECT TITLE: Directed Energy Program
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	41,808	29,854	30,000

PROJECT DESCRIPTION:
The Space Based Laser (SBL) program was created to provide the nation with a space based boost phase intercept capability option. Major building blocks have been developed; key system integrations and tests lie ahead. Remaining tasks in this project are: to integrate the high-power laser with the large optics beam director and test Alpha-LAMP Integration, (ALI); to integrate Acquisition, Tracking, Pointing (ATP) technologies and test ATP/FC technologies from a high altitude balloon platform against realistic missile targets (High Altitude Balloon Experiment, HABE); to integrate ALI hardware with Acquisition, Tracking, Pointing, and Fire Control (ATP/FC) hardware and test; to integrate ALI/ATP/FC system with spacecraft interfaces; and to build a prototype SBL spacecraft (subscale and ABM Treaty compliant) for first flight test.

In response to Congressional direction the directed energy program was cut back to fit the reduction in available funds. According to the cost constrained plan, only the ALI tests and initial HABE ground test will be accomplished and the high payoff technology programs have been terminated. The high-power Alpha laser has been placed in "maintenance only" status until required by ALI in 1996. After completion of the ALI tests in 1997, the SBL program will be terminated before a complete integration and test of all hardware and without a full-scale evaluation of the nation's only space based laser missile defense option.

PROJECT NUMBER: 1460
PROJECT TITLE: Battle Management, Command, Control, and Communications (BM/C^3)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	27,900	33,538	36,213

PROJECT DESCRIPTION:
The mission of BM/C^3 is to integrate available National Missile Defense (NMD) elements with current and planned command and control structures to provide militarily effective systems. Since exoatmospheric midcourse intercept is the key to an effective NMD system, the BM/C^3 program will develop the capability to obtain information from sensors and supply sufficient target objective map and in-flight target update information to the in-flight interceptor to permit successful destruction of a Reentry Vehicle (RV). The objectives of the BM/C^3 program are: (1) develop the processes, procedures and the functional software needed to demonstrate an early operational BM/C^3 capability and the integration of battle management, command and control and sensor data among, and between NMD elements and supporting external systems; (2) develop human-in-control and related functional capabilities required by the User; (3) identify BM/C^3 technology, manufacturing, producibility, and deployability long poles and performance parame-

ters to minimize these issues in the event of a contingency deployment decision: and (4) support the development of mature operational requirements and Concept Of Operations (CONOPS) which ensure the deployment of the desired end-to-end system behavior.

PROJECT NUMBER: 1651
PROJECT TITLE: Innovative Science and Technology (IS&T)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0602173C RDT&E	45,509	50,739	52,614

PROJECT DESCRIPTION:
To prepare to meet critical future active defense needs, advanced technology programs will invest in a balanced program of high leverage technologies that yield improved capabilities across a selected range of boost phase and terminal defense interceptors, advanced target sensors, and innovative science. The objectives of these investments are to provide (1) component technologies that offer improved performance or reduced costs for our acquisition programs, (2) a better understanding of the physical processes to support the acquisition programs, and (3) technical solution options to mitigate unpredicted threats. This project explores innovative technologies of interest to Ballistic Missile Defense Organization (BMDO). Unlike other BMDO projects that fund near term technology and testing efforts, this project invests seed money in high risk technologies that could dramatically change how Ballistic Missile Defense (BMD) develops future systems. Cause and exploit breakthroughs in science that will keep BMD at the foremost edge of what is possible. Conduct proof-of-concept demonstrations that transition technology to development programs.

Many of today's baseline technologies on BMDO systems like Theater High Altitude Area Defense (THAAD), Extended Range Intercept Technology (ERINT), and Ground Based Radar (GBR) are available only because of wise investment in innovative technology 10 years ago. Examples include: Indium Antimonide and Mercury Cadmium Telluride ultrasensitive detectors, 32-bit Reduced Instruction Set Computer (RISC) processors for image analysis, composite materials for lightweight satellite structures, interferometric fiber optic gyroscopes for sophisticated guidance and control, and solid-state Gallium Arsenide transmitter/receivers for BMDO radars. The IS&T program is the only Research and Development (R&D) program in the Defense Department focussed on future BMDO technical requirements.

These programs will focus, to the maximum extent feasible, on innovative technologies in support of future BMD sensor and interceptor systems. These systems will require processing, sensor, power, optics, propulsion, and communications capabilities beyond those currently being developed. An important goal of the programs is to identify, develop, and demonstrate innovative technologies which will dramatically improve BMD system performance.

PROJECT NUMBER: 1660
PROJECT TITLE: Statutory and Mandated Programs
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0602173C RDT&E	38,496	42,569	52,699
0603173C RDT&E	4,323	4,302	4,323

PROJECT DESCRIPTION:
There are three programs managed under this project:

- Small Business Innovative Research;
- Technology Applications;
- Historically Black Colleges and Universities/Minority Institutions.

The Small Business Innovative Research (SBIR) program explores innovative concepts pursuant to PL102-564 which mandates a two phase competition for small businesses with innovative technologies.

The Technology Applications Program, established in 1986, makes BMD technology available to federal agencies, state and local governments, and U.S. business and research interests. The program objective is to develop and support the transfer of Ballistic Missile Defense (BMD) derived technology to other Department of Defense applications as well as other federal, state and local government agencies, federal laboratories, universities, and the domestic, commerical, and private sector.

The Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) Program increases and improves the participation of these colleges and institutions in the BMDO program. It also responds to Section 832 of PL 101-510 which establishes a specific goal within the overall five percent goal for HBCU and MIs and introduces them to BMDO technologies and the particulars of the BMDO procurement process.

Each program will focus, to the maximum extent feasible, on innovative technologies in support of future BMD sensor and interceptor systems. These systems will require processing, sensor-power, optics, propulsion, and communications capabilities beyond those currently being developed. An important goal of each program is to identify, develop, and demonstrate innovative technologies which will dramatically improve BMD system performance.

PROJECT NUMBER: 2154
PROJECT TITLE: Theater Missile Defense-Ground Based Radar (TMD-GBR)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603861C RDT&E	171,828	162,558	8,188
0604861C RDT&E	0	0	204,000

PROJECT DESCRIPTION:

The Theater Missile Defense-Ground Based Radar (TMD-GBR) is the acquisition and fire control radar of the Theater High Altitude Area Defense (THAAD) weapon system. TMD-GBR is designed to provide threat early warning, threat type classification, interceptor fire control, external sensor cueing, launch and impact point estimates for the THAAD weapon system (project 2260). Also, the TMD-GBR is required to provide cueing support to other TMD systems such as PATRIOT. TMD-GBR is based on state-of-the-art solid-state X-band radar technologies. The TMD-GBR program will purchase one Demonstration And Validation (Dem/Val) radar and two User Operational Evaluation System (UOES) radars. The TMD-GBR Dem/Val radar will be used to support the initial radar integration and interceptor tests at White Sands Missile Range in FY 1995, continuing radar characterization tests at Unitied States Army Kwajalein Atoll (USAKA) in FY 1996. At the end of the TMD-GBR Dem/Val program the Dem/Val radar and its associated equipment will be transferred to the National Missile Defense-Radar Technology Demonstrator (NMD-RTD) program. The User Operational Evaluation Systems (UOES) radars will continue integrated THAAD weapon system testing in FY 1996 and be available for Limited User Tests and contingency deployments in FY 1997. The Engineering and Manufacturing Development (EMD) program will expand the UOES performance characteristics to meet the Operational Requirements Document (ORD) objective system requirements. Included in the TMD-GBR program is a Solid-state Demonstration Array (SSDA) program, concentrating on increased transmit/receive module performance and producibility and maintaining the ability for competitive award of the EMD effort.

PROJECT NUMBER: 2160
PROJECT TITLE: TMD Existing System Modifications
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	**FY 1996**	**FY 1997**
0603872C RDT&E	15,701	26,869	25,000

PROJECT DESCRIPTION:

The Theater Missile Defense (TMD) program is structured to field a defensive capability against theater ballistic missiles as quickly as possible by upgrading existing active defense systems while developing more advanced TMD capabilities. As such, TMD improvements can be made incrementally.

This project provides the enhancement of warning and surveillance capabilities, including fixed and mobile ground based tactical processing of launch detection data (from the Defense Support Program (DSP), space early warning systems, or other means) and netted surveillance to support intercepts and broader defense coverage.

This project implements non-Major Defense Acquisition Program (MDAP) modifications to current and existing warning and surveillance systems that result in fielded improvements to TMD capabilities. This project consists of three programs; Cueing and Netting, TALON SHIELD, and Extended Airborne Global Launch Evaluator (EAGLE).

- Cueing And Netting-

Cueing and Netting is a program developing software and hardware modifications for PATRIOT which will allow PATRIOT to receive and process cueing data from theater sensors such as the Joint Tactical Ground Station (JTAGS) and the TPS-59. These cues allow early track initiation and allow planning for multiple shot engagements.

- TALON SHIELD -

TALON SHIELD processing equipment, located at Falcon Air Force Base, receives and processes DSP and other national intelligence data on Theater Ballistic Missile (TBM) events to provide timely warning of TBM launch point, time, and azimuth, and impact point prediction to tactical units. Processing equipment is located at the National Test Facility (NTF). This program is related to Army JTAGS and Air Force Attack and Launch Early Reporting to Theater (ALERT) programs.

- EAGLE -

The EAGLE is developing and fielding a TBM detection, tracking, and cueing system aboard Air Force E-3 Airborne Warning and Control System (AWACS) aircraft. Consisting of a passive Infrared Search and Track (IRST) sensor and an eye safe laser ranger, EAGLE provides precise cues to deployed Theater Missile Defense-Ground Based Radar (TMD-GBR) and SPY-1 fire control radars, as well as early, highly accurate improved estimates of TBM launch points and impact points. EAGLE's precise tracking begins before booster burnout and continues through the early post-boost phase of missile flight. Against long-range TBMs, EAGLE will track in-flight missiles prior to their detection by surface based radars, which are constrained by viewing limitations imposed by curvature of the earth. EAGLE target cues will be much more accurate than those available from TALON SHIELD or JTAGS, which do not support extended range, single-beam radar acquisition of long-range TBMs. EAGLE's highly accurate prediction of a TBM's future trajectory makes it unnecessary for fire control radars to search for a missile, enabling the radars to acquire the TBM earlier, at longer range, using a single, precisely pointed radar beam. This longer range acquisition permits earlier launch of interceptors, yielding a dramatic increase in the defended area (footprint) for Theater High Altitude Area Defense (THAAD) and SM-2 Blk IVA.

PROJECT NUMBER: 2257
PROJECT TITLE: PATRIOT
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0208865C PROC	253,272	399,463	413,608
0604865C RDT&E	276,283	247,921	160,070
0604866C RDT&E	74,000	19,485	9,760

PROJECT DESCRIPTION:
PATRIOT is a long-range, mobile, field Army and Corps air defense system, which uses guided missiles to simultaneously engage and destroy multiple targets at varying ranges. The PATRIOT Advanced Capability Level-3 (PAC-3) Upgrade Program is the latest evolution of the phased material change improvement program to PATRIOT. The material changes will provide improved performance across the spectrum for system and threat intercept performance. The material changes include a new PAC-3 missile (previously known as Extended Range Intercept Technology (ERINT)), remote launch capabilities, communications and computer/software improvements, and radar upgrades to enhance system performance by improving its multifunction capability for tracking, and target handling capability against air breathing, ballistic and cruise missile threats. The PATRIOT operates as lower tier of the Army's Theater Missile Defense (TMD) enclave concept and is developing the capacity to interact with the Navy Cooperative Engagement Capability (CEC) system.

This project includes risk reduction activities associated with the PAC-3 system including the PAC-3 missile. There are three sets of activities; the PAC-3 missile and system integration activities; the Mountain Top Demonstration; and captive carry and Hardware-In-The-Loop (HWIL) testing of a 16" seeker. This project addresses PAC-3 missile system risks including; system integration of the PAC-3 missile; maneuvering reentry threat vehicles; Electronic Counter-countermeasures; relocation of threat vehicle payloads and low altitude and, low radar cross-section cruise missiles in a high clutter and or adverse weather environment.

PROJECT NUMBER: 2259
PROJECT TITLE: Israeli Cooperative Projects
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	**FY 1996**	**FY 1997**
0603173C RDT&E	3,000	0	0
0603872C RDT&E	48,068	56,558	44,200

PROJECT DESCRIPTION:
This project includes the Arrow Continuation Experiments (ACES) Project, the Arrow Deployability Project (ADP), the Israeli Test Bed (ITB), the Israeli System Engineering and Integration (ISE&I) Project, the Israeli Boost Phase Intercept (BPI) System Study (IBIS) and the Israeli Co-Operative Research and Development project.

Arrow Continuation Experiments (ACES) is a U.S.-Government of Israel (GOI) initiative to assist the GOI to develop an Anti-tactical Ballistic Missile (ATBM) interceptor and to provide the basis for an informed engineering and manufacturing decision for an ATBM defense capability and to provide the U.S. with technology information and data. ACES is a follow-on to the Arrow Experiments project that developed the preprototype Arrow I interceptor. The first phase of ACES, completed in the third quarter FY 1994, featured critical lethality tests using the Arrow I interceptor with the Arrow II warhead. The second phase of ACES consists of the design, development and test of the Arrow II interceptor. If successful, the Arrow II will satisfy the Israeli requirement for an interceptor for defense of military assets and population centers and will support U.S. technology base requirements for new advanced anti-tactical ballistic missile technolo-

gies that could be incorporated into the U.S. two tier Theater Missile Defense (TMD) system.

After U.S. planning activities in FY 1994, the Arrow Deployability Project (ADP) in FY 1995 starts to pursue the research and development of technologies associated with the deployment of the Arrow Weapon System and to permit the Government of Israel to make a decision on its own initiative regarding deployment of this system without financial participation by the U.S. beyond the Research and Development (R&D) stage. This effort will include three system-level flight tests of the U.S.-Israeli cooperatively developed Arrow II interceptor and launcher supported by the Israeli-developed fire control radar and battle management control center. Studies will be done to define interfaces required for Arrow Weapon System interoperability with U.S. TMD systems, lethality, kill assessment and producibility. Prior to obligation of funds to execute ADP R&D efforts, the President must certify to the Congress that a Memorandum of Agreement (MOA) exists with Israel for these projects, that each project provides benefits to the U.S., that the Arrow missile has completed a successful intercept, and that the Government of Israel continues to adhere to export controls-pursuant to the Missile Technology Control Regime (MTCR). Subsequent U.S.-Israeli cooperative R&D on other ballistic missile defense concepts would occur in the future.

The Israeli Test Bed (ITB) Program is a cooperative effort between the U.S. and the GOI. The ITB is a medium to high fidelity theater missile defense simulation that provides the capability to evaluate potential Israeli missile defenses, aids the Israeli Ministry Of Defense (IMOD) in the decision of which defense systems to field, provides insights into man's role in TMD, and trains personnel to function in a TMD environment. A structured set of joint U.S./Israeli experiments is being executed to evaluate the role of missile defenses in both mature and contingency Middle East theater operations. This funding also provides for a portion of the operation and maintenance of the ITB and planned enhancements. Completed experiments identified additional enhancements needed to improve the ITB as an analysis tool. The enhancements incorporated in the ITB to date include an adaptive radar simulation, an improved threat model and a Boost Phase Intercept (BPI) simulation. The BPI enhancement benefits the Israeli BPI study. The planned Adaptive Battle Management Center (BMC) enhancement will benefit the U.S. by enabling the ITB to simulate a wide variety of command and control and interoperability issues.

The Israeli System Engineering and Integration (ISE&I) continues to provide analyses and Arrow Weapon System architecture options in support of the Israeli Missile Defense System. The specific activities that comprise the ISE&I effort are: Arrow Weapon System Design, ACES Conformance, ITB Conformance, Hypervelocity Weapon System Study, Lethality Study, Kill Assessment Study, and analysis of experiments conducted on the HYBRID model to address the complex multiparameter problems that arise in TMD systems analysis. The ISE&I effort provides support to the ITB project by serving as the on-site monitor of ITB enhancement efforts, responding to problems encountered in the experiments effort, obtaining or developing needed algorithms and schemes for accomplishing various defensive tasks, serving as the liaison between the ITB effort and the ACES Project, and serving as the expert on Israeli defensive strategies and plans. The ISE&I effort also provides expert assessments and analysis of radar related modeling issues.

The Israeli BPI Study showed the feasibility and utility of using high altitude, long endurance Unmaned Aerial Vehicles (UAVs) to perform very stressing missile defense missions to protect the State of Israel. A preliminary cost and operational effectiveness assessment concluded that

such a system could be very complementary to Arrow and developed quickly with indigenous Israeli technology.

The Israel Cooperative Research and Development Project will advance emerging TMD technologies to the technology demonstration phase to provide for the defense of the State of Israel, support U.S. technology base needs for these technologies, and pursue interoperability with U.S. TMD systems. Candidate technologies today are the continuation of the electrothermal gun experiments and advancement of the Israeli Boost Phase Intercept concept. Efforts in this area will not begin until FY 1997. This timing provides for maturation of U.S. requirements for these areas of TMD technologies.

PROJECT NUMBER: 2260
PROJECT TITLE: THAAD
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603861C RDT&E	453,051	413,769	64,000
0604861C RDT&E	0	0	460,000
0604861C MILCON	0	13,600	4,700
0603872C RDT&E	27,022	0	0

PROJECT DESCRIPTION:
The Theater High Altitude Area Defense (THAAD) system is being designed to negate Theater Ballistic Missiles (TBM) at long ranges and high altitudes. Its long-range intercept capability will make possible the protection of broad areas, dispersed assets, and population centers against TBM attacks. THAAD, combined with the Theater Missile Defense-Ground Based Radar (TMD-GBR), forms the THAAD system. The TMD-GBR (Project 2154) provides fire control and surveillance for THAAD. THAAD will be interoperable with both existing and future air defense systems. This netted and distributed Battle Management/Command, Control, Communications, Integration (BM/C^3I) architecture will provide robust protection against the TBM threat spectrum. The THAAD element includes missiles, launchers, BM/C^3I units, and support equipment.

The THAAD Demonstration And Validation (Dem/Val) program will develop a design for the objective THAAD system and demonstrate the capabilities of the system in a series of 14 flight tests. The residual hardware resulting from the Dem/Val program (to include an option for 40 missiles) will be used for a prototype "battalion" called the User Operational Evaluation System (UOES). The UOES will be used for early operational assessment and for soldiers to influence the final design, but will also be available for use as a contingency capability during a national emergency. It is projected to consist of four launchers, two BM/C^3I units, two TMD-GBRs and support equipment with an option to procure 40 missiles. Due to the accelerated Dem/Val program schedule, the UOES and Dem/Val flight test system components will not have the full functionality required for the objective THAAD system. Sufficient functionality will be included to fully demonstrate the system capabilities, resolve technical issues to support advanced development, and satisfy all exit criteria for Milestone II. The production of the UOES will provide valuable risk reduction benefit for the objective system and will facilitate early user testing. The objective system design will be developed and tested in the Engineering, Manufacturing, and

Development (EMD) phase. This phase will lead to low rate initial production and subsequent fielding in the 2002 time frame.

During FY 1995 and FY 1996 the Dem/Val flight test program will be conducted at White Sands Missile Range (WSMR), New Mexico. The flight test schedule consists of 14 flights and system tests which began in April 1995. The first flight verified the basic operations of the THAAD missile. THAAD's first intercept of a target TBM will occur in the third flight test planned in the fourth quarter of FY 1995.

PROJECT NUMBER: 2262
PROJECT TITLE: MEADS (formerly Corps SAM)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603869C RDT&E	14,971	30,442	33,400

PROJECT DESCRIPTION:
The Corps SAM program has been focused on satisfying the critical need to provide low-to-medium air and theater missile defense to the maneuver forces and other U.S. and allied critical forward deployed assets from attack by both ballistic missiles and air breathing threats. In February 1995, the Department of Defense (DoD) signed a multilateral Statement of Intent (SOI) with Germany, France, and Italy to cooperate on the joint development of a medium air and missile defense system referred to as the Medium Extended Air Defense System (MEADS). This joint international program will now develop this capability. The system will support force projection operations from early entry to decisive operations. It will consist of missiles, launchers, sensors, and Battle Management Command, Control, Communications, Computers, and Intelligence (BM/C^4I) elements. The system will be easily transportable by all strategic and tactical lift aircraft. The system is to begin Project Definition and Validation (PD&V) in FY 1996.

PROJECT NUMBER: 2263
PROJECT TITLE: Sea Based Area Theater Ballistic Missile Defense (TBMD) (Lower Tier)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0208867C PROC	14,394	16,897	91,561
0603867C RDT&E	139,676	0	0
0604867C RDT&E	0	237,473	193,600

PROJECT DESCRIPTION:
The Navy Area TBMD project builds on the national investment in AEGIS ships, weapon systems, and missiles. Two classes of ships continue to be deployed with the AEGIS combat system:

the CG-47 Ticonderoga-class cruisers and the DDG-51 Burke-class destroyers. Navy theater ballistic missile defense capability will take advantage of the attributes of naval forces including overseas presence, mobility, flexibility, and sustainability in order to provide protection to debarkation ports, coastal airfields, amphibious objective areas, Allied forces ashore, population centers, and other high value sites. Navy assets will provide an option for an initial Theater Ballistic Missile (TBM) defense for the insertion of additional land based TBMD assets and other expeditionary forces in an opposed environment.

This project provides:

- Modifications to the AEGIS combat system (ACS) to include modifications to the command and decision system, the AEGIS display system, and the radar system (AN/SPY-1B/D);
- Modifications to the STANDARD Missile (SM-2 Block IV) and the AEGIS weapon control system with a STANDARD Missile (SM- 2 Block IVA) in FY 2000 capable of engaging TBMs in the endoatmosphere;
- Fielding a User Operational Evaluation System (UOES) consisting of the SM-2 Block IVA and selected, limited non-tactical ACS modifications in FY 1998 if required to counter an existing threat.

PROJECT NUMBER: 2358
PROJECT TITLE: HAWK System BM/C^3
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0208863C PROC	3,804	5,106	20,430
0603863C RDT&E	26,800	23,188	0

PROJECT DESCRIPTION:
This project will provide a Theater Missile Defense (TMD) capability for U.S. Marine Corps operations. This Marine Corps' TMD initiative is jointly funded with Ballistic Missile Defense Organization (BMDO) and will yield a low risk, near term capability for expeditionary forces against short-range ballistic missiles. The program consists of modifying the TPS-59 long-range air surveillance radar and the HAWK weapon system to allow detection, tracking, and engagement of short-range Theater Ballistic Missiles (TBMs). The program will also provide a communications interface by developing an Air Defense Communications Platform (ADCP).

Modifications to the TMD mode of the TPS-59 radar will add a ballistic missile detection and tracking capability. Technical, developmental, and operational testing is scheduled for FY 1996 with first units equipped in early FY 1997.

The HAWK weapon system modifications include upgrades to the battery command post and improvements to the HAWK missile that will result in a missile configuration called the "improved lethality missile". The modified HAWK battery command post will process cueing

data to control the high-power illuminator radar. The improved lethality missile will incorporate fuse and warhead improvements. Improved lethality missile modification kits will be procurred and installed by the end of FY 1996. Production of the battery command post modification kits will begin in FY 1995. The installation of all battery command post modifications will be completed by the end of FY 1996.

The Air Defense Communications Platform (ADCP) will convert TPS-59 data messages and Tactical Data Information Link-J (TADIL-J) formatted messages into the intra-battery data link formats required by the HAWK weapon system. The ADCP will also transmit TADIL-J formatted messages to other theater sensors. This communications interface is currently in development and initial production will begin in FY 1996.

PROJECT NUMBER: 3152
PROJECT TITLE: NMD System Engineering
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	**FY 1996**	**FY 1997**
0603871C RDT&E	20,402	19,357	17,975

PROJECT DESCRIPTION:
The National Missile Defense (NMD) Program's goal is to develop and maintain the option to deploy a cost-effective, operationally effective and Antiballistic Missile (ABM) Treaty compliant system designed to protect the United States against limited ballistic missile threats, including accidental or unauthorized launches or third world attacks. The NMD system elements are the Ground Based Interceptor (GBI); the Ground Based Radar (GBR), the Space and Missile Tracking System (SMTS), and Battle Management/Command, Control and Communications (BM/C^3). This project provides the engineering, analysis, and documentation necessary: to translate user requirements into system and element requirements needed to build, integrate, and test the system; to evaluate alternative system architectures (combinations of system elements) for the purpose of selecting those that best meet program needs and constraints; to develop and evaluate various contingency deployment options as a hedge against the emergence of unexpected threats; and, to develop an investment strategy that leverages TMD developments and supporting technologies in a way that best utilizes scarce program resources. Funds are provided to develop system simulations at the National Test Facility (NTF) which support user concept of operation development and evaluation (war gaming), identifying Command and Control (C^2) interfaces and interoperability issues, and modeling architecture alternatives. The project also includes survivability assessments.

PROJECT NUMBER: 3153
PROJECT TITLE: Architecture Analysis / BM/C^3 Initiatives
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	7,392	0	0
0603871C RDT&E	0	3,110	3,125
0603872C RDT&E	4,820	9,330	9,375

PROJECT DESCRIPTION:

This project ensures that issues relating to system architecture and Battle Management/Command, Control and Communications (BM/C^3) are addressed in a coordinated and synergistic manner across all Ballistic Missile Defense Organization (BMDO) National Missile Defense (NMD) and Theater Missile Defense (TMD) efforts. This project includes systems analyses of alternative ballistic missile defense architectures and concepts. These analyses are independent studies of element designs, architecture performance, alternative architectures and their performance, architecture costs, and insertion of emerging technologies into the system elements to reduce costs and increase effectiveness. Efforts also include mission analyses and simulations which focus on defining ballistic missile defense concepts; the impact of these concepts on international stability, deterrence, and arms control; and strategic and tactical effectiveness of proposed architectures.

Efforts also include the system-level oversight and coordination of all BMDO BM/C^3 development and acquisition activities in the role of senior advisor to the Director, BMDO. This effort will provide for the synergistic formulation and execution of all BMD Advanced Development BM/C^3 research, development, and acquisition activities across TMD and NMD Program Elements.

PROJECT NUMBER: 3157
PROJECT TITLE: Environment, Siting, and Facilities
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	5,606	0	0
0603871C MILCON	530	832	974
0603871C RDT&E	0	1,345	1,351
0603872C MILCON	0	2,577	2,961
0603872C RDT&E	0	4,036	4,054

PROJECT DESCRIPTION:

This project provides environmental program guidance, environmental impact analyses and documentation, real property facility siting, and facility management and acquisition support for National Missile Defense (NMD) and Theater Missile Defense (TMD). The project plans, programs, budgets, and oversees the facility acquisition through Military Construction (MILCON) and Research Development Test and Evaluation (RDT&E) construction projects. The project provides guidance and leads Ballistic Missile Defense Organization (BMDO) environmental compliance, pollution prevention, other environmental efforts, and the Environmental Assessment and Environmental Impact Statement for NMD and TMD activities. The project develops guidance

for Executing Agents on facility siting, facility acquisition, and environmental matters. The project includes MILCON design funds to support design of BMDO's major and minor MILCON projects.

PROJECT NUMBER: 3160
PROJECT TITLE: Readiness Planning
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	13,470	14,469	17,302
0603872C RDT&E	1,146	1,951	1,960

PROJECT DESCRIPTION:
For National Missile Defense (NMD), this project identifies deployment activities and impacts on fielding an operationally effective, treaty compliant ABM capability within the shortest possible time. The near term program activities focus on critical path analysis to identify those activities providing the greatest time reduction potential. This effort not only identifies time reduction activities, but monitors those activities to ensure time reduction reality and it includes such items as state-of-the-art element/component insertion, producibility engineering, industrial base capacity assessment, specialty engineering, risk mitigation activities, development of site activation requirements, and supportability planning for schedule and affordability issues resolution. This information, and its relationship to the NMD program, is described in a contingency deployment planning document and includes all NMD architecture options. Yearly funding is necessary to resolve critical time line issues to include site design, environmental impact, and Military Construction (MILCON) as the NMD Readiness program reaches its first phase of maturity. The contingency deployment plan, updated annually, will guide the NMD Readiness Program and define the NMD Contingency Deployment System. Systems analysis efforts focus on NMD-wide assessments of budget formulation and execution, systems integration, and systems effectiveness. These assessments contribute to reducing NMD program risks and ensuring the availability of a cost-effective Antiballistic Missile (ABM) system.

This effort also includes identifying and tracking the U.S. industrial base capabilities, as well as the support and training infrastructure needed for a potential NMD deployment. The operational suitability activities integrate specialty engineering functions at the Ballistic Missile Defense (BMD) level including producibility, acquisition logistics, training, etc, for NMD. Another emphasis of the program is to ensure that critical pacing of subsystems meets required performance criteria. This emphasis is currently in metrology, to generate measurement standards for long wavelength infrared focal planes critical for both Theater Missile Defense (TMD) and NMD components.

For TMD, this project supports the development of TMD systems with emphasis on producibility trade-offs and logistics supportability concepts and their integration into the diverse TMD elements. The project focuses these activities by coordinating efforts between the Services. The TMD readiness activities include producibility and planning for manufacturing, acquisition logistics, metrology, and training. The efforts will concentrate on identifing and analyzing critical

TMD systems level deployment, support, producibility and manufacturing risks, industrial base capability issues and developing mitigation plans for these areas to ensure operational requirements and Ballistic Missile Defense Organization (BMDO) affordability objectives are met.

PROJECT NUMBER: 3251
PROJECT TITLE: Systems Engineering and Technical Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603872C RDT&E	53,207	47,836	56,926

PROJECT DESCRIPTION:
This project provides system engineering and technical support for the integration of Service supplied weapon systems to facilitate the identification and resolution of inter-Service integration and interoperability issues; technical and engineering assessments and trade-off studies of Theater Missile Defense (TMD) system architectures and concepts; support for United Kingdom (U.K.) sensor data fusion studies; Ballistic Missile Defense (BMD) system survivability oversight and assessment; risk reduction and acquisition streamlining support; modeling, simulation, experiment, and flight test support; development and maintenance of technical and programmatic data bases; and preparation of technical reports, briefings, and programmatic documentation associated with TMD studies and critical issues.

PROJECT NUMBER: 3261
PROJECT TITLE: BM/C^{3}I Concepts
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0208864C PROC	0	32,242	20,300
0603864C RDT&E	20,009	24,231	24,425
0604864C RDT&E	534	14,301	17,976

PROJECT DESCRIPTION:
The primary mission of this project is to provide the warfighter with an integrated and interoperable Theater Missile Defense (TMD) Battle Management/Command, Control, Communications, and Intelligence (BM/C^{3}I) capability having the flexibility to meet a wide range of threats and expected needs. The BM/C^{3}I architecture for TMD is built upon the existing Command and Control (C^2) structure for Theater Air Defense (TAD) and adds the communications linking TMD C^2 nodes, weapons, and sensors, and the TMD interfaces to intelligence systems and other supporting capabilities. The Ballistic Missile Defense Organization (BMDO), from its joint perspective, uses this project to oversee independent weapon systems development and to provide guidance, standards, equipment, integration, and analysis to maximize the performance of a multitude of sensors, interceptors, and C^2 nodes and to synergize their individual contributions to an integrated Joint theater-wide TMD system. BMDO has three major thrusts to the TMD BM/C^{3}I program.

The first thrust establishes the links and means for receipt and in-theater dissemination of launch warning information from space based and intelligence systems external to TMD. This project supports the system engineering of their capability and prototype development of items such as gateways between National Technical Means and the Joint Data Network. Some elements of this thrust are funded separately under different programs such as the Joint Tactical Ground Station (JTAGS). This project focuses on the efforts to link these separate systems into the theater.

The second thrust of the BM/C^3I program focuses on the communication of information via the Joint Data Net and interoperability among systems. Interoperability includes both the communications equipment, links, and protocols and the common command and control procedures between different weapons systems to ensure a truly integrated theater-wide ballistic missile defense system. The cornerstone of TMD interoperability and the Joint Data Net is the Joint Tactical Information Distribution System (JTIDS) and the Tactical Data Information Link-J (TADIL-J) message format. This project builds upon existing TAD C^2 networks to develop and implement new messages and links necessary for ballistic missile engagements. It includes the integration of JTIDS terminals into Theater Ballistic Missile Defense (TBMD) C^2 platforms and the software upgrades necessary to utilize new TBMD information within the C^2 systems. Funding for FY 1996 includes initial procurement of JTIDS terminals for the Joint Data Net, the start of integrating terminals into multi-Service platforms, and UOES implementation.

The third thrust of the BM/C^3I program directs attention to the Service upgrades of C^2 centers. Various command center upgrades are included in this project to reduce decision making time necessary to effectively engage ballistic missiles. Again, BMDO leverages off several existing Service funded theater air defense command center upgrades and this project funds only the specific TMD related aspects of these upgrades. BMDO's central direction and support of hardware and software developments will produce an integrated C^2 capability for TMD.

The effects of early warning, improved interoperability, integration, and command center upgrades on current and emerging TBMD doctrine are operationally analyzed through war games, simulation, and modeling to optimize the integrated Joint Theater Ballistic Missile Defense System in support of the Joint Forces Commander.

All of the efforts in this project are designed to provide a seamless interoperable architecture to provide timely warning and information necessary to reduce decision times and allow more opportunities to efficiently and effectively engage hostile missiles. The desired end result is to kill more missiles and reduce casualties to U.S. and friendly forces.

PROJECT NUMBER: 3265
PROJECT TITLE: User Interface
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	1,248	1,443	1,530
0603872C RDT&E	12,603	16,843	16,926

PROJECT DESCRIPTION:

Development of an effective National Missile Defense (NMD) program requires a close user interface to ensure user and developer consistency with respect to operational requirements, concepts of operation, and integration of multi-Service systems. This project supports Ballistic Missile Defense Organization's (BMDO's) NMD interface with the military operational community through integrated development of war game simulations using NMD Models to evaluate operational requirements and concepts of operations. Analyses and simulations are performed to address system effectiveness of proposed NMD system architectures against near and far term ballistic missile threats. Results support activities required for strategic gaming with CINCs to identify roles, missions, and requirements for NMD. Funds from this project are also provided to operational users for development and refinement of operational requirements and concepts of operation for employment of NMD. NMD war games are the vehicle by which these concepts are integrated into the overall Ballistic Missile Defense (BMD) system deployment strategy and planning.

For Theater Missile Defense (TMD), this project supports the Commander in Chiefs (CINCs) in the execution of various exercises to provide the basis for the assessment, development, and improvement of TMD capabilities. This project integrates new technology and hardware into the CINC exercises to examine its effectiveness and contribution to the TMD mission. The program enables the collection of operational data that is used to evaluate the effectiveness of TMD systems, architectures and operational concepts. The project provides a framework for the CINCs to perform TMD training and make TMD part of everyday business. Also, this project provides the basis for the integration of User Operational Evaluation Systems (UOESs). A UOES is a prototype operational system of hardware and procedures which will be user operated for field evaluation purposes. Through the UOES program the CINCs develop battle management command, control, and communications architectures, formulate and test operational concepts, and determine operational requirements.

This project also supports the interfaces that must be provided to the military operational community. Analyses and simulations address systems effectiveness of proposed BMD system architectures against ballistic missile threats to U.S. deployed forces, our Allies and friends. Analytical results are used to support activities required for the Defense acquisition process. Theater and strategic gaming with the CINCs is supported to identify roles, missions, and requirements for BMD. Funds are also provided from this project to operational users to enable them to develop and refine their Operational Requirement Documents (ORDs) and Concept Of Operations (CONOPS) for employing BMD and ensuring that these concept are integrated into the overall BMD system deployment strategy and planning.

PROJECT NUMBER: 3270
PROJECT TITLE: Threat and Countermeasures Program
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	30,167	0	0
0603871C RDT&E	0	8,272	8,312
0603872C RDT&E	0	24,810	24,931

PROJECT DESCRIPTION:
The Ballistic Missile Defense Organization (BMDO) Threat and Countermeasures Program defines potential adversary military systems and forces, principally theater and strategic missiles, which the Ballistic Missile Defense (BMD) system could confront. To accomplish this mission, BMDO has a threat definition and development program which is based on Intelligence Community projections and is traceable to quantifiable analysis. The Program comprises three component tasks: Intelligence Threat, Countermeasures Integration, and System Threat Scenario Generation.

- Intelligence Threat Task -

The BMD Intelligence Threat task provides intelligence community validated National Missile Defense (NMD) and Theater Missile Defense (TMD) threat descriptions. The Intelligence Threat task divides the threat into four major categories: Operational Threat Environment, Targets, System Specific Threats (SST), and Reactive Threats. Operational Threat Environment includes assessments of the NMD and TMD operational and technological environments and projects the effects of developments and trends on mission capability. Targets include a projection of foreign theater and strategic missile threat systems and the countermeasures that enhance their performance. This includes force structure, performance characteristics, and sample signatures. System Specific Threat includes reconnaissance, surveillance, and target acquisition; lethal and nonlethal threats; and regional integrated SST assessments. Reactive Threats are those that an adversary may develop as a result of deployment of U.S. NMD and TMD systems.

- System Threat Scenario Generation Task -

The accurate specification and characterization of ballistic missiles and the appropriate development and integration of scenarios using these characterizations are critical to the analysis of alternative ballistic missile architectures, the performance assessments of potential technology applications, and the operational performance evaluations of candidate designs. This task provides baseline and excursion scenario descriptions in documentary and magnetic form for use in BMDO TMD Cost and Operational Effectiveness Analysis (COEA) evaluations and NMD system and architecture analyses. These descriptions are the only approved threat employment portrayals authorized for acceptable BMDO analysis. This task:

- Identifies user needs for threat scenario descriptions.
- Identifies analyses needed to fully specify and characterize the threat missile systems, penetration aids, tactics, etc., and ensures the analyses are accomplished;
- Provides the analysis results to all interested agencies for review and comment;
- Addresses critical threat issues which arise during the analysis process;
- Ensures all supporting agencies' views on threat issues are fully aired;
- Reviews, approves, produces, and distributes all System Threat Scenario Descriptions;
- Produces threat computer tapes and supporting documentation for use by the development and acquisition communities.

- Countermeasures Integration Task -

The BMDO Countermeasure Integration (CMI) Program assists BMD acquisition program offices in developing ballistic missile defense systems that are robust to potential countermeasures and are practical and within the means of anticipated adversaries. Included is support to the BMD threat development process and advance warning to BMDO system designers. The CMI program determines the effectiveness of potential countermeasures through analysis, high fidelity simulations, and ground and flight tests. The BMDO CMI Program reviews BMD systems for susceptibilities and identifies potential countermeasure concepts. CMI then analyses the potential effectiveness of each countermeasure concept and characterizes credible countermeasures by providing designs and performance parameters. The CMI program informs intelligence and system threat developers of potential countermeasures, informs BMD system designers with advance warning of potential countermeasures, and assists BMD system designers in developing counter-countermeasures. Providing vulnerability and susceptibility information to the system designers early enables them to build robustness into their designs during the early stages of the system development process, a cost-effective means for providing a flexible high performance design.

PROJECT NUMBER: 3352
PROJECT TITLE: Modeling and Simulations
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	3,000	0	0
0603871C RDT&E	19,000	15,779	26,834
0603872C RDT&E	64,801	70,521	57,486

PROJECT DESCRIPTION:
This project provides for the development of validated models and simulation techniques and tools that are critical in assessing the performance capabilities of Ballistic Missile Defense (BMD) systems. This is a highly complex problem requiring high performance vector and parallel processing supercomputers as well as scalar processors and advanced graphic workstations. This cost-effective approach will reduce high cost missile test programs and will establish requirements for future technology. This capability is housed at the National Test Facility (NTF), and the Advanced Research Center/Simulation Center (ARC/SC). These facilities are capable of operating in a distributed integrated simulation environment and hosts modeling and simulation war games that provide the analysis, integration, demonstration, and performance verification capability for BMD systems. These facilities are provided to all Services and procedures have been established that ensure efficient utilization and sound verification, validation, and accreditation.

PROJECT NUMBER: 3354
PROJECT TITLE: Targets Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603872C RDT&E	64,042	26,091	29,900

PROJECT DESCRIPTION:

This project provides targets and services needed to support the testing and evaluation of BMD programs. It is a segment of the Ballistic Missile Defense Organization (BMDO) Consolidated Targets Program (CTP). The CTP mission is to provide threat representative ballistic missile target system support to interceptor and sensor development and acquisition programs. For Theater Missile Defense (TMD) this project funds the development of target systems and Foreign Military Acquisition (FMA) to support TMD test and evaluation. Also funded are the refurbishment and support costs of retired missile systems components that are used to construct the target systems. The Theater High Altitude Area Defense (THAAD), PATRIOT Advanced Capability Level-3 (PAC-3), and Navy programs require target system support to accomplish their planned test and evaluation. The THAAD program intends to use the newly developed Hera target system with planned launches from White Sands, NM and Wake Island into the Kwajalein Missile Range (KMR) impact area. The PAC-3 program will use Storm and Hera targets launched from White Sands and the Navy may use Hera targets launched from Pacific Missile Range Facility (PMRF) Barking Sands, Kauai, HI into open ocean impact areas.

For National Missile Defense (NMD), this project provides threat-credible ballistic missile target system support to interceptor and sensor development and acquisition programs. The Midcourse Space Experiment (MSX) and Exoatmospheric Kill Vehicle (EKV) programs require target system support to accomplish their planned test and evaluation. The MSX program intends to use the Strategic Target System(STARS) launched from Barking Sands, Kauai; while the EKV program plans to use Minuteman (MM II) equipped with the Multi-Service Launch System (MSLS), launched from Vandenberg AFB.

PROJECT NUMBER: 3359
PROJECT TITLE: System Test & Evaluation
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603871C RDT&E	14,100	17,904	18,382
0603872C RDT&E	27,758	47,137	46,720

PROJECT DESCRIPTION:

This effort provides for Test Readiness Program (TRP) planning oversight and coordination of integrated Test and Evaluation activities and interelement, as well as inter-Service Test and Evaluation efforts. It provides independent evaluation of systems technology programs and special reviews. This effort provides funding for the TRP Test and Evaluation Summary (TES) which outlines testing for the National Missile Defense (NMD) TRP. It also provides funding for the Integrated System Test Capability (ISTC) Development. This tool provides NMD system level Hardware-In-The-Loop (HWIL) testing. For Theater Missile Defense (TMD), the project provides credible estimates of kinetic energy weapon lethality against theater ballistic missiles and fidelity models and simulation to support system development testing. Another objective of this program is the execution of independent technical reviews, system analyses and performance

evaluations which contribute to the development of the Ballistic Missile Defense (BMD) family of systems and to the successful achievement of acquisition milestones. The performance evaluation has as its primary goals the identification and understanding of system-level performance drivers and the mitigation of technical risk. Efforts include short-term special studies, focused technical investigations, and participation in test readiness reviews intending to ensure successful test and experiments.

PROJECT NUMBER: 3360
PROJECT TITLE: Test Resources
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0603173C RDT&E	6,963	0	0
0603871C RDT&E	11,558	11,411	11,951
0603872C RDT&E	25,585	34,237	35,853

PROJECT DESCRIPTION:
This project provides for test infrastructure for common ground test facilities and range instrumentation. The common ground test facilities include: the Kinetic Kill Vehicle Hardware-in-the-Loop Simulator (KHILS) at Eglin AFB, Fort Walton Beach, FL; the Hypervelocity Wind Tunnel Number 9 (Tunnel 9) at the Naval Surface Warfare Center, White Oak, MD; the Aero-optical Evaluation Center (AOEC) located at Calspan Corp., Buffalo, NY; the Kinetic Energy Weapon Digital Emulation Center (KDEC) at U.S. Army Space and Strategic Defense Command, Huntsville, AL; the Army Missile Optical Range (AMOR) at the U.S. Army Missile Command, Huntsville, AL; the Portable Optical Sensor Tester (POST) and the Characterization of Low Background Mosaics (CALM) at Rockwell International, Anaheim, CA; the Naval Research and Development (NRaD) facility located at the Naval Command, Control and Ocean Surveillance Center, San Diego, CA; the National Hover Test Facility (NHTF) at Edwards AFB, CA; the Center for Research Support (CERES) located at Falcon AFB, Colorado Springs, CO; and the infrared and blackbody standards at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. The common range facilities include national ranges such as: the White Sands Missile Range (WSMR) located in Las Cruces, NM; the Kwajalein Missile Range (KMR) with the Wake Island Complex located in the Marshall Islands; the Pacific Missile Range Facility (PMRF) located at Kauai, HI; the Gulf Test Range (GTR) located at Eglin AFB, Fort Walton Beach, FL.; the Eastern Test Range (ETR) located at Patrick AFB, Cape Canaveral, FL; and the Western Test Range (WTR) at Vandenburg AFB, Lompoc, CA. The range instrumentation includes special test equipment, data collection assets, and range instrumentation upgrades including: the High Altitude Observatory (HALO) with the Infrared Imaging System (IRIS) sensor, based at Aeromet, Inc., Tulsa, OK; and the Rapid Optical Beam Steering (ROBS) system, the Sea-Lite Beam Director (SLBD), the Experimental Test System (ETS), and the High Altitude Optical Imaging System (HAOIS), all based at White Sands Missile Range, Las Cruces, NM. The range instrumentation includes special test equipment, data collection assets, and range instrumentation upgrades including the Kwajalein Missile Range Safety System (KMRSS) located at the Kwajalein Missile Range (KMR) in the Marshall Islands. These ground test facilities, ranges, and instrumentation assets provide valuable program risk reduction and test implementation capability in support of the ballistic missile defense test and evaluation program. The ground test facilities provide a cost-effective method of testing and evaluating applicable component and sub-

system level technologies. The range instrumentation provides a cost-effective capability to collect test vehicle characteristics and performance data on flight tests. These facilities and capabilities support component design, verification and validation of target realism, and the evaluation of test results.

PROJECT NUMBER: 4000
PROJECT TITLE: Program Management
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY 1995	FY 1996	FY 1997
0605218C RDT&E	163,206	185,542	188,418
0603871C RDT&E	3,330	0	0

PROJECT DESCRIPTION:

This project provides support in three basic areas: personnel and related support costs; funding for meeting fluctuation costs and contract terminations; and assistance required to fund support service contracts.

Personnel and related support costs common to all BMDO projects include support of the Office of the Director, Ballistic Missile Defense Organization and his staff located within the Washington, D.C. area, as well as BMDO's Executing Agents within the U.S. Army Space & Strategic Defense Command, U.S. Army PEO Missile Defense, U.S. Navy PEO for Theater Defense, U.S. Air Force PEO office, and the National Test Facility. This project supports funding for personnel salaries, benefits, and supportive costs such as rents, utilities, supplies, etc.

This project provides funding to meet operational, contractual, and statutory fiscal requirements. Operational requirements include reimbursable services acquired through the Defense Business Operating Fund (DBOF), such as accounting services provided by the Defense Finance and Accounting Service (DFAS). Contractual requirements include reserves for special termination costs on designated contracts and provisions for terminating other programs as required. BMDO has additional requirements to provide for foreign currency fluctuations on its limited number of foreign contracts. Finally, statutory requirements include funding for charges to cancelled appropriations in accordance with Public Law 101-510.

Assistance required to support BMDO overhead management functions includes contracts to fully support functions such as ADP operations, access control, and graphics support, as well as to supplement the BMDO government personnel. Typical efforts include cost estimating, security management, contracts management, strategic relations management and information management. These efforts include assessment of technical project design, development and testing, test planning, assessment of technology maturity and technology integration across BMDO projects; and support of design reviews and technology interface meetings. Program control tasks include assessment of schedule, cost, and performance, with attendant documentation of the many related programmatic issues. The requirement for this area is based on most economical and efficient utilization of contractors versus government personnel.

Appendix B

Annual Report To Congress Missile Defense

Annual Report To Congress On Ballistic Missile Defense

Reporting requirements for the Annual Report to Congress on Ballistic Missile Defense as specified by section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991, as amended by section 240 of the National Defense Authorization Act for Fiscal Year 1994:

(1) A statement of the basic strategy for research and development being pursued by the Department under the Ballistic Missile Defense program, including the relative priority being given, respectively, to the development of near-term deployment options and research of longer term technological approaches.

(2) A detailed description of each program or project which is included in the Ballistic Missile Defense program or which otherwise relates to defense against strategic ballistic missiles, including a technical evaluation of each such program or project and an assessment as to when each can be brought to full-scale engineering development (Engineering Manufacturing Development)(assuming funding as requested or programmed).

(3) A clear definition of the objectives of each planned deployment phase of the Ballistic Missile Defense program or defense against strategic ballistic missiles.

(4) An explanation of the relationship between each such phase and each program and project associated with the proposed architecture for that phase.

(5) The status of consultations with the other member nations of the North Atlantic Treaty Organization, Japan, and other appropriate allies concerning research being conducted in the Ballistic Missile Defense program.

(6) A statement of the compliance of the planned BMD development and testing programs with existing arms control agreements, including the 1972 Antiballistic Missile Treaty.

(7) A review of possible countermeasures of the Soviet Union to specific BMD programs, an estimate of the time and cost required for the Soviet Union to develop each such countermeasure, and an evaluation of the adequacy of the BMD programs described in the report to respond to such countermeasures.

(8) Details regarding funding of programs and projects for the Ballistic Missile Defense program (including the amounts authorized, appropriated, and made available for obligation after undistributed reductions or other offsetting reductions were carried out), as follows:

(A) The level of requested and appropriated funding provided for the current fiscal year for each program and project in the Ballistic Missile Defense program budgetary presentation materials provided to Congress.

(B) The aggregate amount of funding provided for previous fiscal years (including the current fiscal year) for each program and project.

(C) The amount requested to be appropriated for each such program and project for the next fiscal year.

(D) The amount programmed to be requested for each such program and project for the following fiscal year.

(E) The amount required to reach the next significant milestone for each demonstration program and each major technology program.

(9) Details on what Ballistic Missile Defense program technologies can be developed or deployed within the next 5 to 10 years to defend against significant military threats and help accomplish critical military missions. The missions to be considered include the following:

(A) Defending elements of the Armed Forces abroad and United States allies against tactical ballistic missiles, particularly new and highly accurate shorter range ballistic missiles of the former Soviet Union armed with conventional, chemical, or nuclear warheads.

(B) Defending against an accidental launch of strategic ballistic missiles against the United States.

(C) Defending against a limited but militarily effective attack by the former Soviet Union aimed at disrupting the National Command Authority or other valuable military assets.

(D) Providing sufficient warning and tracking information to defend or effectively evade possible attacks by the former Soviet Union against military satellites, including those in high orbits.

(E) Provide early warning and attack assessment information and the necessary survivable Command, Control, and Communications to facilitate the use of United States military forces in defense against possible conventional or strategic attacks by the fomer Soviet Union.

(F) Providing protection of the United States population from a nuclear attack by the former Soviet Union.

(G) Any other significant near-term military mission that the application of BMD technologies might help to accomplish.

(10) For each of the near-term military missions listed in paragraph (9), the report shall include the folowing:

(A) A list of specific program elements of the Ballistic Missile Defense program that are pertinent to such mission.

(B) The Secretary's estimate of the initial operating capability dates for the architecture of systems to accomplish such missions.

(C) The Secretary's estimate of the level of funding necessary for each program to reach those initial operating capability dates.

(D) The Secretary's estimate of the survivability or Cost Effectiveness at the Margin of such architectures or systems against current and projected threats from the former Soviet Union.

Appendix C

Acronyms

Acronyms

AAWC	Anti-Air Warfare Commander
ABCS	Advanced Beam Control System
ABCCC	Airborne Command and Control Center
ABL	Airborne Laser
ABM	Antiballistic Missile
ACAP	Advanced Capabilities
ACCS	Airspace Command/Control System
ACE	(ARM) Countermeasure Evaluator
ACE	Allied Command Europe
ACES	Arrow Continuation Experiments
ACS	AEGIS Combat System
ACS	Attitude Control System
ACTD	Advanced Concept Technology Demonstration
ADCP	Air Defense Communications Platform
ADP	Arrow Deployability Project
ADTOC	Air Defense Tactical Operations Center
ADWC	Air Defense Warfare Center
AF/TAA	Air Force Executive Agent For Theater Air Defense
AGARD	Advisory Group On Aerospace Research and Development
AGRE	Active Geophysical Rocket Experiment
AHWG	Ad Hoc Working Group
AIRFOR	Air Force
AIST	Advanced Interceptor and Systems Technology
AIT	Atmospheric Interceptor Technology
ALERT	Attack and Launch Early Reporting To Theater

ALI	Alpha/LAMP Integration
AMG	Antenna Mast Group
AMOR	Army Missile Optical Range
AOA	Airborne Optical Adjunct
AOC	Air Operations Center
AOEC	Aero-Optical Evaluation Center
APEX	Advanced Phase Conjugation Experiment
ARC/SC	Advanced Researched Center / Simulation Center
ARM	Anti-Radiation Missile
ARRC	ACE Rapid Reaction Corps
ASAS	Advanced Solid Axial Stage
AST	Advanced Sensor Technology
AST	Airborne Surveillance Testbed
ASTP	Advanced Sensor Technology Program
ATACMS	Army Tactical Missile System
ATBM	Anti-Tactical Ballistic Missile
ATP	Acceptance Test Program
ATP/FC	Acquisition, Tracking, Pointing and Fire Control
AWACS	Airborne Warning And Control System
BE	Brilliant Eyes
BPI	Boost Phase Intercept/Interceptor
BM/C^3	Battle Management/Command, Control, and Communications
BM/C^{3}I	Battle Management/Command, Control, Communications, Integration
BM/C^{3}I	Battle Management/Command, Control, Communications, Intelligence
BM/C^{4}I	Battle Management Command, Control, Communications, Computers and Intelligence
BMC	Battle Management Center
BMD	Ballistic Missile Defense

BMDO	Ballistic Missile Defense Organization
BMEWS	Ballistic Missile Early Warning System
BTH	Below The Horizon
BTTV	Ballistic Tactical Target Vehicle
BUR	Bottom-Up Review
C^2	Command and Control
C^4I	Command, Control, Communications, Computers and Intelligence
CALM	Characterization Of Low Background Mosaics
CCD	Camouflage, Concealment and Deception
CD	Concept Definition
CDI	Classification, Discrimination and Identification
CDP	Contingency Deployment Plan
CDR	Critical Design Review
CDS	Congressional Descriptive Summaries
CEC	Cooperative Engagement Capability
CERES	Center For Research Support
CEU	Cooling Equipment Unit
CG	Cruiser (Guided Missile)
CIC	Combat Information Center
CINC	Commander In Chief
CL	Chemical Laser
CMI	Countermeasures Integration
CNAD	Conference Of National Armaments Directors
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept Of Operations
CONUS	Continental United States
Corps SAM	Corps Surface to Air Missile
COTS	Commercial-Off-The-Shelf

CRC	Command Report Center
CRP	Command and Reporting Post
CSEDS	Combat System Engineering Development
CTAPS	Contingency TACS Automated Planning System
CTP	Consolidated Targets Program
CVN	Aircraft Carrier (Nuclear Propulsion)
DBOF	Defense Business Operating Fund
DC-X	Delta Clipper Experiment
Dem/Val	Demonstration and Validation
DFAS	Defense Finance and Accounting Service
DGP	Defense Group - Proliferation
DoD	Department of Defense
DRAM	Dynamic Random Access Memory
D/S	Down Select
DSP	Defense Support Program
E-2	Hawkeye Aircraft
E^3	Electromagnetic Environmental Effects
EAD/TMD	Extended Air Defense / Theater Missile Defense
EAGLE	Extended Airborne Global Launch Evaluator
ECC	Experiment Control Center
ECS	Engagement Control Station
EEU	Electronic Equipment Unit
EFEX	Endoatmospheric Aerothermal Mechanics Flight Experiment
EIS	Environmental Impact Statement
EKV	Exoatmospheric Kill Vehicle
EMD	Engineering and Manufacturing Development
EPP	Electric Power Plant

ERINT	Extended Range Intercept Technology
ERIS	Exoatmospheric Reentry Vehicle Intercept System
ESA	Electronically Scanned Array
ETR	Eastern Test Range
ETS	Experimental Test System
EUCOM	European Command
EWR	Early Warning Radar
FAIT	Fabrication, Assembly, Integration and Test
FDS	Flight Demonstration System
FPA	Focal Plane Array
FMA	Foreign Military Acquisition
FMS	Foreign Military Sales
FSU	Former Soviet Union
FUE	First Unit Equipped
GEM	Guidance Enhancement Missile
GEO	Geosynchronous Earth Orbit
GOI	Government Of Israel
GPALS	Global Protection Against Limited Strike
GPS	Global Positioning System
GTR	Gulf Test Range
HABE	High Altitude Balloon Experiments
HALO	High Altitude Observatory
HAOIS	High Altitude Optical Imaging System
HAWK	Homing All The Way Killer
HBCU/MI	Historically Black Colleges and Universities/Minority Institutions
HELSTF	High Energy Laser System Test Facility
HF	High Frequency

HIC	Human-in-Control
HIT	Heterojuncture Internal Photoemissive
HWIL	Hardware-in-the-Loop
IA	Information Architecture
IBIS	Israeli BPI System Study
ICBM	Intercontinental Ballistic Missile
ID	Identification
IDG	Institute For The Dynamics Of Geospheres
IFICS	Inflight Interceptor Communication System
IFT	Integrated Flight Test
IFTU	In-flight Target Update
I-HAWK	Improved HAWK
IGT	Integrated Ground Tests
IMOD	Israeli Ministry Of Defense
IMU	Inertial Measurement Units
INS	Inertial Navigation System
IPSRU	Inertial Pseudo Stellar Reference Unit
IR	Infrared
IR&D	Independent Research and Development
IRST	Infrared Search and Track
ISE&I	Israeli System Engineering And Integration
ISTC	Integrated Systems Test Capability
ITB	Israeli Test Bed
JADO	Joint Air Defense Operations
JEZ	Joint Engagement Zone
JFACC	Joint Force Air Component Commander
JHU/APL	Johns Hopkins University Applied Physics Laboratory

JIEO	Joint Interoperability Engineering Organization
JMCIS	Joint Maritime Command Information System
JMSWG	Joint Multi-TADIL Standards Working Group
JOB	Joint Oversight Board
JSTARS	Joint Surveillance and Target Attack Radar System
JTAGS	Joint Tactical Ground Station
JTIDS	Joint Tactical Information Distribution System
KDEC	Kinetic Energy Weapon Digital Emulation Center
KE	Kinetic Energy
KHILS	Kinetic Kill Vehicle Hardware-in-the-Loop Simulator
KKV	Kinetic Kill Vehicle
KMR	Kwajalein Missile Range
KMRSS	Kwajalein Missile Range Safety System
KV	Kill Vehicle
LADAR	Laser Detection And Ranging
LAMP	Large Advanced Mirror Program
LDS	Lexington Discrimination System
LEAP	Lightweight Exoatmospheric Projectile
LHD	Amphibious Assault Ship
LOS	Large Optical Segment
LRIP	Low Rate Initial Production
LS	Launching Station
LWIR	Long Wavelength Infrared
M&S	Materials And Structures
M/LWIR	Medium/Long Wavelength Infrared
MAGTF	Marine Air Ground Task Force
MARFOR	Marine Force

MDAP	Major Defense Acquisition Program
MEADS	Medium Extended Air Defense System
MILCON	Military Construction
MIRV	Multiple Independently - Targetable Reentry Vehicle
MMIC	Monolithic Microwave Integrated Circuit
MMM	Multimode Missile
MOU	Memoranda Of Understanding
MS II	Milestone II
MSLS	Multi-Service Launch System
MSTI	Miniature Sensor Technology Integration
MSX	Midcourse Space Experiment
MTCR	Missile Technology Control Regime
MTTV	Maneuvering Tactical Target Vehicle
MWIR	Medium Wavelength Infrared
NASA	National Aeronautics and Space Adminisitration
NATO	North Atlantic Treaty Organization
NAVFOR	Navy Force
NHTF	National Hover Test Facility
NIAG	NATO Industrial Advisory Group
NII	National Information Infrastructure
NILES	NATO Improved Link Eleven System
NIST	National Institute Of Standards and Technology
NMD	National Missile Defense
NRaD	Naval Research and Development
NTB	National Test Bed
NTF	National Test Facility
NTMG	National Technical Means Gateway

OCU	Operator Control Unit
ODES	Operational and Developmental Experiments Simulator
ORACL HYLTE	Overtone Research Advanced Chemical Laser Hypersonic Low Temperature
ORD	Operational Requirements Document
OSD	Office, Secretary of Defense
OTA	Office Of Technology Applications
PAC-2	PATRIOT Advanced Capability Level-2
PAC-3	PATRIOT Advanced Capability Level-3
PATRIOT	Phased Array Tracking To Intercept Of Target
PDR	Preliminary Design Review
PD-V	Project Definition-Validation
PE	Program Element
PET	Pilotline Experimental Technology
PLV	Payload Launch Vehicle
PMRF	Pacific Missile Range Facility
POST	Portable Optical Sensor Tester
PtSi	Platinum Silicide
PVT	Payload Verification Tests
QRP	Quick Reaction Program
RAM	Radom Access Memory
R&D	Research And Development
RAMOS	Russian-American Observation Satellites
RDT&E	Research Development Test And Evaluation
RFP	Request For Proposal
RISC	Reduced Instruction Set Computer
ROBS	Rapid Optical Beam Steering

ROW	Rest-of-World
RRAD	Rapid Response Air Defense
RS	Radar Set
RTD	Radar Technology Demonstrator
RV	Reentry Vehicle
SALT	Strategic Arms Limitation Talks
SBIR	Small Business Innovation Research
SBIRS	Space Based Infrared System
SBL	Space Based Laser
SBS	Stimulated Brillouin Scattering
SCORE	Scientific Cooperative Research Exchange
SDI	Strategic Defense Initiative
SDR	Software Design Review
SEO	Survivability Enhancement Options
SHAPE	Supreme Headquarters Allied Powers Europe
SHIELD	Silicon Hybrid Extrinsic Long-wavelength Detector
SLBD	Sea Lite Beam Director
SLBM	Submarine Launched Ballistic Missile
SLS	Shoot-Look-Shoot
SM	Standard Missile
SMTS	Space and Missile Tracking System
SOI	Statement Of Intent
SPICE	Space Integrated Controls Equipment
SRD	System Requirements Document
SRR	System Requirement Review
SSDA	Solid-state Demonstration Array
SSGM	Synthetic Scene Generation Model

SSRT	Single Stage Rocket Technology
SST	System Specific Threats
STARS	Strategic Tactical Airborne Range System
STARS	Strategic Target System
STEP	Space Test Experiment Platform
STRV-2	Space Test Research Vehicle-2
SWIL	Software-in-the-Loop
SWIR	Short Wavelength Infrared
TACC	Tactical Air Command Center
TACDAR	Tactical Data and Related Applications
TACS	Theater Air Control System
TAD	Theater Air Defense
TADIL-J	Tactical Data Information Link-J
TAOC	Tactical Air Operations Center
TBM	Tactical Ballistic Missile
TBM	Theater Ballistic Missile
TBMD	Tactical Ballistic Missile Defense
TBMD	Theater Ballistic Missile Defense
TCMP	TMD Critical Measurements Program
TDDS	TRAP Data Dissemination System
TDNS	Theater Defense Netting Study
TES	Tactical Event System
TES	Test and Evaluation Summary
THAAD	Theater High Altitude Area Defense
TIBS	Tactical Information Broadcast Service
TMD	Theater Missile Defense
TMD-GBR	Theater Missile Defense - Ground Based Radar

TMDI	Theater Missile Defense Initiative
TMDSE	TMD System Exerciser
TOAM	Tactical Air Operations Module
TOC	Tactical Operation Center
TOM	Target Object Map
TOPAZ	Thermionic Experiment Conversion Active Zone In Core
TRADOC	Training And Doctrine Command
TRAP	Tactical and Related Operations
TRP	Test Readiness Program
TSB	Target Signatures and Backgrounds
TSD	Tactical Surveillance Demonstration
TSDE	Tactical Surveillance Demonstration Enhancements
TSWG	Target Signature Working Group
UAV	Unmanned Aerial Vehicle
UEWR	Upgraded Early Warning Radar
UHF	Ultra High Frequency
UOES	User Operational Evaluation System
USACOM	United States Atlantic Command
USAKA	United States Army Kwajalein Atoll
USCENTCOM	United States Central Command
USD(A&T)	Under Secretary Of Defense (Acquisition And Technology)
USEUCOM	United States European Command
USFK	United States Forces Korea
USMC	United States Marine Corps
USPACOM	United States Pacific Command
USSPACECOM	United States Space Command
WDM	Wavelength Division Multiplexer

WEU	Western European Union
WMD	Weapons Of Mass Destruction
WSMR	White Sands Missile Range
WTR	Western Test Range